THE DEPARTMENT OF ENERGY'S NUCLEAR R & D PROGRAMMES

CONSULTATION DOCUMENT

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FOREWORD

by the Secretary of State for Energy

The Government has recently brought about a number of major changes in the electricity supply industry in the UK. Privatisation has replaced a monopoly in electricity generation by a competitive commercial market. New generators are coming forward and new sources of generation are being developed. The creation of Nuclear Electric and Scottish Nuclear has enabled the costs and benefits of nuclear power to be assessed on a more open and realistic basis.

The Government made clear in the White Paper "This Common Inheritance" that it wishes to maintain the nuclear option, provided nuclear power becomes economic and the industry continues to maintain its high safety and environmental standards. Economic nuclear power can make an important contribution to the diversity and security of the UK's energy supplies and in combating global warming. R & D has an important role to play in meeting these economic, safety and environmental objectives.

The Government believes that, in line with its policy on R & D generally, the chief responsibility for funding R & D in support of nuclear power should rest with the nuclear industry. At the same time the Government may need to commission R & D itself both in support of its policy and regulatory functions and in connection with its funding responsibilities in the areas of decommissioning and waste management.

In recent years, an increasing proportion of nuclear R & D has been funded by the nuclear industry. But the Department of Energy is continuing to spend large sums itself on nuclear R & D (some £94 million in 1991/92). In the light of the recent changes to the structure of the nuclear industry, the time has come to consider the range and level of nuclear R & D funded by the Department and whether it is well-focussed in relation to the Department's responsibilities and objectives. I consider it essential that the Department continues to secure maximum value for money from its nuclear R & D programmes.

This Consultation Document therefore reviews how the Department of Energy's nuclear R & D programmes support the Government's nuclear policy and reaches preliminary conclusions about their future direction. It describes the changes the Department has adopted, and is proposing, to ensure that it is better informed about the nuclear R & D it commissions and that the work is carried out cost-effectively.

I believe that open discussion of nuclear issues is very important if the nuclear industry is to achieve the public acceptability which is so essential to its future. That is why I am publishing this Consultation Document and inviting comments. I hope it will encourage a wide-ranging and informed debate about the range and direction of the Department's nuclear R & D programmes and I look forward to seeing the views expressed. In the light of comments received, I intend to publish an overall strategy for the Department's nuclear R & D programmes.

JOHN WAKEHAM

THE DEPARTMENT OF ENERGY'S NUCLEAR
R & D PROGRAMMES

A CONSULTATION DOCUMENT

CHAPTER ONE: THE GOVERNMENT'S NUCLEAR POLICY AND THE BACKGROUND TO THE PRESENT REVIEW

1.1 The Department of Energy's nuclear R & D programmes are designed to support the Government's nuclear policies. In the last few years there have been developments in nuclear policy and changes in the structure of the nuclear industry. The Department has therefore undertaken a review of its nuclear R & D programmes and reached preliminary conclusions about their future direction and scope. This Consultation Document invites comments on the Department's conclusions, the programmes themselves and on how they might be undertaken in the most cost-effective manner. It also invites comments and suggestions from organisations which might wish to be considered to carry out work funded under the Department's nuclear R & D programmes.

1.2 This is the first time the Department of Energy has published a Consultation Document reviewing - and inviting comments on - its nuclear R & D programmes. The publication of this Document underlines the Government's commitment to open discussion of nuclear issues. This is essential if the nuclear industry is to command public acceptability.

THE GOVERNMENT'S NUCLEAR POLICY

1.3 The Government's nuclear policy was set out in the White Paper on the Environment entitled "This Common Inheritance" (Cm 1200) which was published last September.

1.4 The Government recognises two main advantages to continued nuclear power generation. First, the use of nuclear power increases the diversity of energy supply and thus helps maintain security of supply. Secondly, nuclear power can help to curb acid rain and combat global warming, since nuclear stations emit practically no sulphur dioxide or nitrogen oxides (the main ingredients of acid rain) or carbon dioxide (the principal greenhouse gas). If the electricity currently provided by nuclear power stations in the UK was generated by coal, total carbon emissions in the UK would increase by around 15 million tonnes per year, an increase of nearly 10% over present levels. In addition to these benefits, nuclear power has long term potential, since recycling reprocessed fuel could double the energy extracted from uranium by conventional reactors and could increase it one-hundred fold with fast breeder reactors. This makes the UK's existing holding of uranium equivalent in energy terms to some 45,000 million tonnes of coal, about the same as the UK's total economically-recoverable coal resources.

1.5 For these reasons, the Government wishes to maintain the nuclear option, but only if nuclear power becomes economic and the industry demonstrates it can maintain its high standards of safety and environmental protection.

The 1994 review

1.6 The Government has said that it will undertake a full-scale review of the prospects for nuclear power in 1994, in the light of progress with the completion of Sizewell B, the expected cost of nuclear and fossil-fuelled generation, and diversity of supply and environmental considerations. The review will be wide-ranging and will take account of all relevant factors. Its terms of reference will be decided nearer the time. By 1994 Sizewell B should be nearing completion and it should then be evident whether the station is being built to time and to cost. Meanwhile, the Government has stated that capital investment approval will not be given to Nuclear Electric before the 1994 review for any new nuclear power station beyond Sizewell B, such as the proposed PWR at Hinkley Point for which consent and planning permission was given by the Secretary of State on 6 September 1990.

CHANGES IN THE NUCLEAR INDUSTRY IN THE UK

1.7 On 9 November 1989 the Government announced that the nuclear assets of the CEGB and the South of Scotland Electricity Board (SSEB) would remain in the public sector and be owned and managed by publicly-owned companies. These companies - Nuclear Electric plc (NE) in the case of England and Wales and Scottish Nuclear (SNL) in Scotland - were vested on 31 March 1990.

Changes in the AEA

1.8 There have also been major changes underway in the AEA, both internally and in its relationship to the Department of Energy. The AEA was established by Act of Parliament in 1954 as a Government-funded body responsible for developing civil nuclear power. In 1986, it was placed on a trading fund basis allowing it to adopt a more commercial approach while remaining an independent source of nuclear R & D. The AEA has remained the principal nuclear R & D organisation in the UK, funded by Government and by other parts of the industry.

1.9 With Government support, the AEA has been developing a more commercial approach towards its activities. On 1 April 1990 the AEA reorganised its trading activities into 9 separate Businesses, each with its own Chief Executive. Each Business has its own dedicated staff and can subcontract work to and from other Businesses as well as contract for support services from AEA Sites, which has a separate management structure. On 1 April 1991, the AEA created a separate Corporate DRAWMOPS Directorate (CDD) responsible for ensuring that the AEA's decommissioning and radioactive waste management operations (DRAWMOPS) are carried out safely, economically and effectively.

Relationship between the AEA and the Department of Energy

1.10 Up to now all of the nuclear R & D funded by the Department of Energy has been undertaken by the AEA. In some cases - such as fusion - most of the relevant expertise in the UK lies in the AEA. But elsewhere other bodies (such as Nuclear Electric, SNL, BNFL, NNC Ltd, universities, consultancies and others) may be able to undertake some of the nuclear R & D which the Department of Energy wishes to see done. It should therefore be possible for the Department to employ contractors other than the AEA in particular areas where this offers the prospect of better value for money.

1.11 These issues are discussed further in Chapter Ten of this Document. The approach outlined above would clearly have implications for the role of the AEA. The AEA would remain a major nuclear R & D contractor but it would be competing for nuclear R & D work with other firms and organisations.

THE PRESENT REVIEW

1.12 The report of the House of Commons Energy Select Committee on the Department of Energy's Spending Plans for 1990-91 recommended (paragraph 7) that the Department should undertake a fundamental review of the structure and size of its R & D expenditure. The Government's reply made clear that the Department of Energy would be developing new initiatives in the area of energy efficiency; that it would be reviewing its renewables R & D programme and its civil nuclear R & D programme during 1991; and that it was assessing its role on coal R & D. All these reviews are underway.

1.13 The Environment White Paper last September announced that the Department of Energy would publish a strategy for its civil nuclear R & D programmes, taking account of a review by the nuclear industry of its R & D and of nuclear R & D funded by other Government Departments.

1.14 In recent years the Department of Energy has conducted major reviews of its expenditure on its fast reactor, fusion and reactor safety programmes. These reviews are described in detail in chapters 7, 8 and 4 respectively of this Consultation Document. In brief, the reviews reached the following conclusions:-

(i) The Fast Reactor

On 21 July 1988 the then Secretary of State for Energy announced that the Department would continue to fund the Prototype Fast Reactor (PFR) at Dounreay until March 1994 and the associated reprocessing plant until 1996/97 to deal with the spent fuel. As from 1990-91, the Department would fund a "core" R & D programme as the basis for continued collaboration with our European Partners in the European Fast Reactor (EFR) Collaboration.

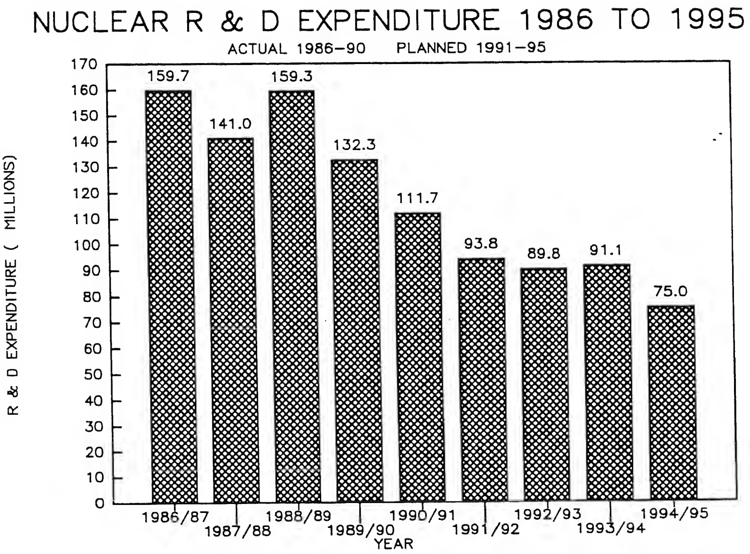
(ii) Fusion

On 27 October 1988 the then Secretary of State announced that the AEA would continue to carry out R & D in support of the Joint European Torus (JET) project at Culham and its programme of work on the tokamak route to fusion. Support for other lines of research would be reduced gradually.

(iii) Reactor Safety

As from April 1990 responsibility for the thermal reactor safety programmes and for most of the General Nuclear Safety programme was transferred from the Department of Energy to the Health & Safety Commission, with the Health & Safety Executive (HSE) taking responsibility for their management, since the HSE was better placed to specify research needs and to manage the programmes. Under the Atomic Energy Act 1989 the HSE was empowered to recover the full costs of the programmes and of their management through levies on the nuclear industry.

1.15 These changes have led to major reductions in nuclear R & D funded by the Department of Energy. The graph below shows how these decisions reduced the Department of Energy's nuclear R & D expenditure up to 1990 and that planned until 1995. Apart from 1988/89, when a technical adjustment to the payment for nuclear programmes resulted in an additional payment in that year, the trend has been strongly downward. Nuclear R & D expenditure planned for 1994/95 is less than half of the expenditure in 1986/87.


NUCLEAR R & D EXPENDITURE 1986 TO 1995

(Expenditure in Money of the Day, £)

ORGANISATION OF THE REVIEW

1.16 The review was organised by a Steering Group under the chairmanship of the Department of Energy. The Group's membership was widely drawn from within Government and comprised representatives of the Department of Energy; the Treasury; the Department of Trade and Industry; the Ministry of Defence; the Department of the Environment; the Cabinet Office; the Health & Safety Executive; the Science & Engineering Research Council; and the Scottish Office. Other Departments - such as the Departments of Health and of Transport - and some representatives of the industry have been involved in the work of the sub-groups established by the Steering Group.

1.17 The terms of reference of the Steering Group are set out at Appendix 1 to this Consultation Document.

1.18 In parallel with the review of the Department's nuclear R & D programmes, the nuclear industry decided to review its own R & D programme and its conclusions have been taken into account in the Department's review. The industry's review was conducted by the R & D Topic Group of the Nuclear Utilities Chairmens' Group (NUCG) under the chairmanship of Mr John Collier, the Chairman of Nuclear Electric. The findings of this Group were made available to the Steering Group and also to the Department's independent Advisory Council on R & D (ACORD) in May of this year. In preparing this Consultation Document, the Department has had the benefit of ACORD's assessment of the industry review and of ACORD's discussion of the conclusions emerging from the Steering Group's own work.

CONTENTS OF THE CONSULTATION DOCUMENT

1.19 Chapter Two of this Consultation Document discusses the principles that underlie the Department's nuclear R & D programmes and draws a number of general conclusions. Chapter Three considers the funding of nuclear R & D by the Department of Energy, other Government Departments and industry. Chapters Four to Nine consider the Department's individual nuclear R & D programmes against the general conclusions outlined in Chapter Two. Chapter Ten discusses the processes by which the Department should commission the nuclear R & D it wishes to have undertaken. Chapter Eleven sets out the provisional conclusions reached by the review, on which the Department would welcome comments.

COMMENTS

1.20 Comments on this Consultation Document should be sent to Dr J M Bird, Room 4.2.18, Department of Energy, 1 Palace Street, London SW1E 5HE by 15 October 1991. In the light of comments received, the Department intends to publish a strategy for its nuclear R & D programmes by the end of the year.

CHAPTER TWO: WHY SHOULD THE DEPARTMENT OF ENERGY FUND NUCLEAR R & D ?

THE DEPARTMENT OF ENERGY'S OBJECTIVES IN SUPPORTING RESEARCH AND DEVELOPMENT

2.1 The Department of Energy has formulated the following objectives for its R and D expenditure:-

(i) to support work which would not otherwise be undertaken on an appropriate timescale or to an extent commensurate with current and future UK needs in order to:-

(a) contribute to the maximum, safe, environmentally acceptable economic exploitation of the energy resources available to the UK both now and in the future;

(b) establish and develop economic options for safe, secure, environmentally acceptable and efficient energy supply, distribution and use for the future;

(c) enable the Department to carry out its statutory and regulatory responsibilities;

(ii) to encourage UK industry and commerce to develop, for the domestic and export market, capabilities, services and technologies related to the efficient supply, distribution and use of energy;

(iii) to ensure the effective dissemination within the UK of the results of R & D work so that timely, commercial development of services, capabilities and technologies based on the work might take place;

(iv) to manage its R & D programme economically and effectively involving, where appropriate, collaborative arrangements at national and international level in order to maximise the benefit for the UK, and to ensure that as technologies approach commercialisation responsibility for funding industrially oriented R & D is progressively transferred to industry.

THE DEPARTMENT OF ENERGY'S NUCLEAR R & D OBJECTIVES

Current Aims

2.2 The present aims of the Department of Energy's nuclear R & D programmes are described in Cm 1505 ("The Government's Expenditure Plans within the Energy Sector 1991-92 to 1993-94", February 1991). This made clear that the Department of Energy's funding of nuclear programmes concentrated on areas of a strategic nature and on certain nuclear safety matters. Where work was directly relevant to a part of industry, industry should fund it direct.

2.3 Cm 1505 described the main aims of the Department's nuclear R & D programmes as follows:-

(i) to obtain independent advice on safety and other aspects of nuclear power development;

(ii) to maintain a position for the UK in the development of fast reactor technology at economic cost;

(iii) to fulfil the UK's obligations to support the European fusion programme in investigating the scientific feasibility of nuclear fusion as a source of electricity in the long term; and

(iv) to fulfil the Secretary of State's responsibilities in regard to the AEA's radioactive waste management and decommissioning liabilities.

2.4 The Department of Energy's nuclear R & D programmes are aimed mainly at helping to meet objectives (i) (a) to (c) of the Department's overall R & D objectives (described in paragraph 2.2).

Present Review

2.5 In considering whether the aims of the Department of Energy's funding of nuclear R & D need to be revised, the review considered them against two main criteria:-

(i) whether the R & D was required and, if so, on what timescale;

(ii) whether it was right for the Department to support the R & D in the light of its objectives or whether it should be done by another body.

2.6 In addition, the review also took into account the fact that most of the nuclear industry - Nuclear Electric, the AEA, SNL, BNFL - is owned by the Government and their R & D expenditure affects the Exchequer. The Government has set these organisations clear commercial objectives, which their nuclear R & D programmes are designed to help them achieve. Most of the industry's nuclear R & D is focussed on short-term business objectives, though BNFL also spend significant amounts on future business prospects. This is discussed further in Chapter 3. The AEA is not an energy industry as such, but a contractor for nuclear R & D.

2.7 In the light of these factors, the review identified three broad aims for Departmental support for nuclear R & D. These are:-

(i) underpinning a clear regulatory framework within which current and prospective future investors in, and operators of, nuclear plants can work;

(ii) ensuring that knowledge of nuclear technologies which have potential for future energy supplies is

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sufficient to enable a proper assessment of them to be carried out in a timescale consistent with their likely economic deployment; and

(iii) enabling the AEA to discharge the decommissioning and waste management liabilities which the Department has accepted mainly as a result of past R & D programmes in a cost-effective way, consistent with acceptable levels of safety; in this respect, the work supported by the R & D is analogous to procurement.

Regulatory Framework

2.8 The Department of Energy's role in regulatory issues arises from:-

(i) the Secretary of State's responsibilities to Parliament for the safety and physical security of civil nuclear installations in England and Wales. The Department itself has no regulatory functions in relation to the safety of nuclear plant. However, the Secretary of State answers to Parliament for the activities of the regulatory authority, the Health and Safety Executive's Nuclear Installations Inspectorate (NII). The Department also has particular responsibilities as lead Government Department for civil nuclear emergency planning. This is the basis of the Department's funding of its General Nuclear Safety Research (GNSR Programme) (Chapter 4);

(ii) its interest in helping to reduce the uncertainties surrounding the health risks associated with nuclear power. This is the basis of the Department's funding of a programme of Radiological Protection Research (RPR) which complements other work funded by the industry and other Government Departments (Chapter 5); and

(iii) the UK's legal obligation to ensure that nuclear materials are used and controlled in accordance with the Euratom and Non-Proliferation Treaties. This is the basis of the Department's Safeguards R & D programme (Chapter 6).

New nuclear technologies

2.9 The Department's funding of R & D into new nuclear technologies has two main objectives. The first is to ensure that knowledge of nuclear technologies with potential for future energy supplies is sufficient to enable them to be properly assessed in a timescale consistent with their likely economic deployment.

2.10 The Department would generally expect the beneficiaries of R & D on new nuclear technologies to fund it, since they are best placed to specify what R & D is required and on what timescale. Unlike the position for some other new energy technologies, the organisations concerned can take well-informed decisions on priorities and have the funds to carry these decisions through. They are therefore in the best position to assess whether or not the R & D is likely to be cost-effective. This should help ensure that the R & D undertaken is properly focussed on market needs and that resources are not wasted. The Department of Energy is, however, funding major programmes in two areas where the timescale is longer than that in which the industry has a close commercial interest, the fast reactor and fusion. These issues are considered further in Chapter 7.

2.11 Second, the Department supports R & D aimed at improvements in technology where this contributes to meeting its other R & D objectives. The DRAWMS and NMM programmes, for instance, fund the development of improved technology to enable the AEA to decommission its plants and manage its wastes safely and cost-effectively (see paragraph 2.12 below).

AEA's Decommissioning and Radioactive Waste Management Operations (DRAWMOPS)

2.12 Under arrangements agreed when the AEA was established as a Trading Fund in 1986, the Department of Energy has accepted responsibility for funding the decommissioning and radioactive waste management liabilities of the AEA insofar as these arise from work carried out before April 1986. It has also accepted responsibility for funding liabilities which have arisen since April 1986 for work carried out with funds from the Department of Energy. The Department of Energy funds the DRAWMS (Decommissioning and Radioactive Waste Management Studies) and NMM (Nuclear Materials Management) R & D programmes in order that the costs should be minised and the work undertaken safely (Chapter 9).

OBSERVATIONS

2.13 Two observations can be made in the light of this assessment of the Department of Energy's nuclear R & D objectives:-

(i) A sizeable proportion of the Department of Energy's nuclear R & D programme is related to the Government's regulatory role or to DRAWMOPS work by the AEA rather than to support for the development of new nuclear energy supply technologies. In 1991/92 the Department of Energy expects to spend about £13 m on programmes related to the Government's regulatory role or to DRAWMOPS, as against around £80 m on the development of new nuclear energy supply technologies. By 1994/95, by which time the Department plans to cease funding the operation of PFR at Dounreay, these figures are expected to be around £18 m and £57 m respectively.

(ii) The Department of Energy's continued funding of R & D in support of the Government's regulatory role, and in relation to the AEA's decommissioning and waste management operations in no way anticipate decisions which may be reached by the 1994 review. The outcome of the 1994 review may influence future fast reactor policy, but the likely timescale for the fast reactor's commercial deployment is some decades away. R & D on fusion is not related to work on the immediate future of power from fission.

CONCLUSIONS

2.14 The review concluded that the objectives of the Department of Energy's nuclear R & D programme should be revised as follows:-

(i) to underpin a clear regulatory framework within which current and prospective future investors in and operators of nuclear plants can work;

(ii) to ensure that knowledge of nuclear technologies which have potential for future energy supplies is sufficient to enable a proper assessment of them to be carried out in a timescale consistent with their likely economic deployment; and

(iii) to enable the AEA to discharge the decommissioning and waste management liabilities which the Department has accepted mainly as a result of past R & D programmes in a cost-effective way, consistent with acceptable levels of safety.

CHAPTER THREE: FUNDING OF CIVIL NUCLEAR R & D IN THE UK: THE PRESENT POSITION

3.1 Nuclear R & D is funded from a variety of sources. Much of the funding for long term R & D comes from the Department of Energy and other Government Departments but there are also contributions from the European Community, the International Atomic Energy Agency (IAEA) and other international bodies. The nuclear industry concentrates mainly on the short term, on R & D on existing power stations and operational technologies. The Research Councils also fund some work in universities and polytechnics, and in their own laboratories, on topics directly or indirectly concerned with nuclear R & D. With the exception of the Medical Research Council's work on radiobiology most of this work is in response to individual research proposals rather than part of an overall programme.

TOTAL NUCLEAR R & D EXPENDITURE IN THE UK

3.2 In 1991-92 total nuclear R & D expenditure in the UK is expected to be almost £258 million (all figures in this chapter are in cash of the year terms):-

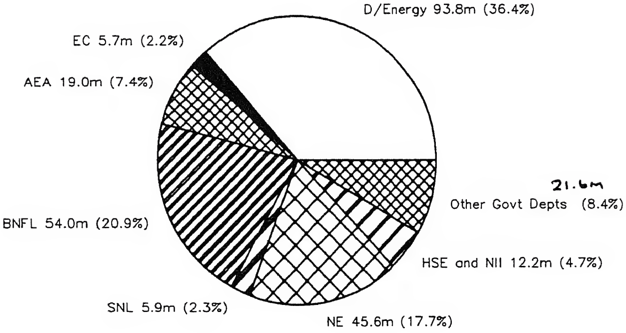


FIG. 1: Nuclear R & D expenditure in the UK by funding organisation, 1991-92 (£)

NB (i) These figures do not include nuclear R & D funded by the Ministry of Defence.

(ii) EC expenditure in the UK includes around £4.2 m on COA (Contract of Association) fusion research and £1.46m on radiological protection research.

(iii) HSE Safety Research Programme and the HSE's NII R & D programme is funded by a levy on NE, SNL and BNFL.

(iv) The AEA figure of £19.0 m in Figure 1 refers to the AEA's Corporate Research and Applications Development. This expenditure includes the development of new applications for technology originally developed from nuclear power and also the development of new technologies for nuclear and non-nuclear applications.

NUCLEAR R & D EXPENDITURE BY GOVERNMENT

3.3 Government bodies expect to spend almost £128 million on nuclear R & D in 1991-92:-

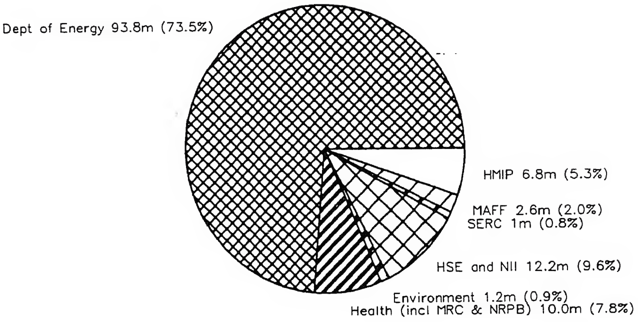


FIG. 2: Nuclear R & D expenditure by Government Departments, 1991-92 (£)

Note: NRPB: National Radiological Protection Board
HMIP: Her Majesty's Inspectorate of Pollution
MAFF: Ministry of Agriculture, Fisheries & Food

3.4 Figure 3 below shows the distribution of Government expenditure (almost £128m) by type of R & D:-

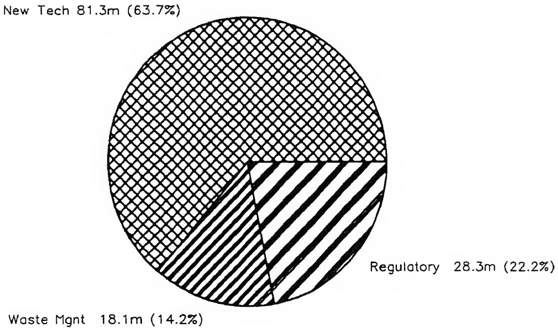


FIG. 3: Nuclear R & D funded by Government by type of R & D, 1991-92 (£)

New technology covers the fast reactor and fusion; waste management includes decommissioning activities; regulatory matters includes safeguards, safety and radiological protection issues.

NUCLEAR R & D EXPENDITURE BY THE DEPARTMENT OF ENERGY

3.5 The Department of Energy expects to spend £93.8m on nuclear R & D in 1991-92 in the following areas:-

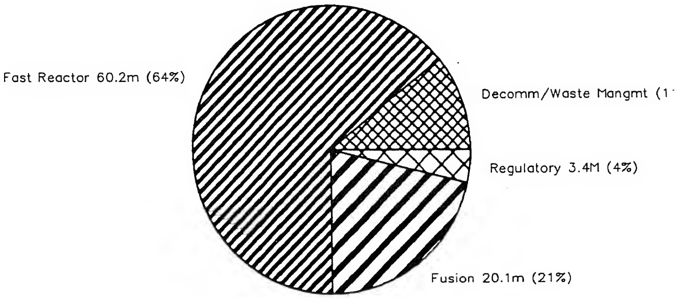


FIG. 4: NUCLEAR R & D FUNDED BY THE DEPARTMENT OF ENERGY BY TYPE OF R & D 1991-92 (£)

NUCLEAR R & D BY THE NUCLEAR INDUSTRY

3.6 In 1991-92 the BNFL, NE, SNL and the AEA expect to spend around £124m on nuclear R & D as follows:-

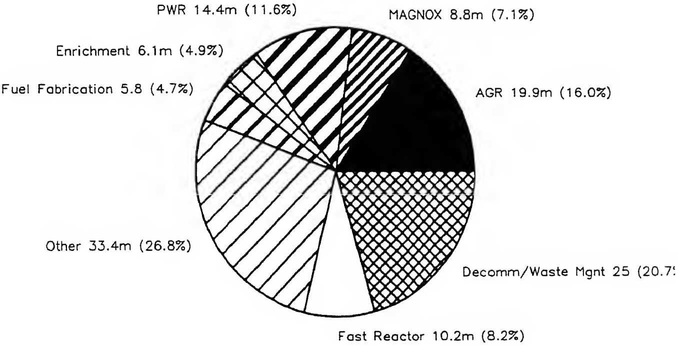


FIG. 5: NUCLEAR R & D FUNDED BY THE NUCLEAR INDUSTRY BY TYPE OF R & D, 1991-92 (£)

This expenditure may be divided between expenditure in support of current business and that in support of new technologies.

Current business

3.7 This includes R & D on existing power stations and existing fuel fabrication and enrichment technology. The nuclear industry's R & D input into safety, health, waste management and decommissioning is covered in subsequent chapters.

3.8 Nuclear Electric are spending £12.0m in support of AGR (Advanced Gas-Cooled Reactor) power station operations and £6.3m in support of Magnox power station operations in 1991-92. This funding is intended, in both cases, to improve performance and extend the life of existing stations. Nuclear Electric's funding in support of AGRs includes £3.5m paid by Scottish Nuclear to Nuclear Electric under collaborative agreements. Nuclear Electric are paying the AEA £2.2 m to carry out work on AGR performance improvement (£1.1 m) and for AGR life extension (£1.1 m).

3.9 BNFL are spending £5.7m and £2.5m in support of AGR and Magnox reprocessing operations respectively. BNFL are spending £6.1m on enrichment technology and a further £5.8m on fuel fabrication methods for AGR stations (£2.3m) and PWR stations (£3.5m).

New technologies

3.10 This includes R & D into new power station types and the activities listed in the table below. The £10.2 million being spent on the fast reactor by Nuclear Electric and BNFL is for design work.

3.11 Nuclear Electric with a contribution from Scottish Nuclear is supporting limited R & D (£0.5m) into specific design areas that could benefit a follow on Sizewell B type PWR and help with the licensing of other designs. £1.8m is being spent by BNFL and a further £0.9m by the AEA.

3.12 Other future business activities funded by the nuclear industry are:-

	NE	SNL	BNFL	AEA
Overseas Collaboration	0.5			
Support for basic science	0.5	0.2	2.4	0.8
Public Attitudes			0.2	
Other	0.1		12.2	9.8

The R & D activities by BNFL listed under "other" include laser enrichment, advanced fuel fabrication, advanced reprocessing and advanced robotics. Other R & D carried out by the AEA includes reactor design development.

CHAPTER FOUR: SAFETY

4.1 All forms of energy entail risks, which must be properly controlled. Nuclear energy is no exception. Risks specific to nuclear energy are the potential for exposure to additional sources of radiation resulting from an accident at a nuclear installation; occupational risks to nuclear workers; and the risks to man and the environment from the handling and disposal of radioactive waste material.

4.2 In the UK, as elsewhere, it is the operators of nuclear installations who are responsible for ensuring that their operations do not endanger staff, the public or the environment. They devote substantial resources to ensuring that such risks are reduced to the lowest reasonable level. As a result of these efforts, the UK nuclear industry has an excellent safety record.

PROGRAMMES UNDERTAKEN BY THE HEALTH AND SAFETY EXECUTIVE (HSE) AND THEIR NUCLEAR INSTALLATIONS INSPECTORATE (NII)

4.3 The funding of safety-related R & D is consistent with the principle of operator responsibility for safety; nearly all such work is funded by the industry. They carry out or commission work themselves and pay for most of the HSE's and the NII's programmes through levy arrangements and nuclear site licence charges respectively.

4.4 The transfer, in April 1990, of programmes previously funded by the Department of Energy to Health and Safety Commission (HSC) sponsorship and HSE management was consistent with this approach. This transfer, of programmes relating to the safety of PWRs, of AGRs and of General Nuclear Safety (ie reactor safety work not specific to any one reactor type), was undertaken because it was considered that the HSE was better placed to specify programme needs, and to monitor their progress, than the Department. The HSC and HSE operate to broad guidelines issued by the Secretary of State for Energy which, among other things, require them to ensure that adequate and balanced programmes of nuclear safety research, based on a view of requirements taken independently of the industry, continue to be carried out. Under the Atomic Energy Act 1989, the HSE are empowered to recover the costs of these programmes through a system of levies on the industry. Expenditure on the HSE levy funded programmes and the work funded directly by the industry in the same areas is expected to amount to some £17.4 million in 1991/92, made up of £8.3 million on PWR, £5.0 million on AGR and £4.2million on General Nuclear Safety Research (GNSR). There are however limits to the HSE's powers to levy for R & D. For example, they do not extend to R & D related to the safety of reactors not currently licensed in the UK or the subject of a licence application.

THE DEPARTMENT OF ENERGY'S CURRENT PROGRAMME

4.5 The Department of Energy has no direct regulatory responsibility for nuclear safety but the Secretary of State for Energy is answerable to Parliament for the safety and the physical security of civil nuclear installations in England and Wales and is thus answerable for the activities of the HSC and the HSE (in particular the HSE's NII) where they relate to nuclear safety. The Department of Energy is also the lead Department for emergency planning in respect of civil nuclear sites in England and Wales. (The Secretary of State for Scotland is answerable to Parliament for civil nuclear safety in Scotland and the Scottish Office is the lead department for civil nuclear emergency planning in Scotland. The Scottish Office does not however undertake R & D in nuclear safety).

4.6 The above responsibilities provide the rationale for the Department of Energy's small programme of General Nuclear Safety Research, which addresses issues relating more closely to the Department's interests and responsibilities than to those of the industry. The programme covers the following areas:

- the composition and chemical form which would be taken by the radioactive fission products released in a nuclear accident.

- mechanisms through which release beyond the nuclear site might take place.

- the possible consequences to the public of such a release under different conditions and taking into account the effects of possible counter measures.

- the safety of advanced reactor designs not currently licensed in the UK.

- international aspects of nuclear safety, including UK/USSR collaboration.

- the security of civil nuclear plant.

4.7 Planned expenditure for this programme in 1991-92 is £1.9 million. All of the programme is currently placed with AEA Technology through their Safety and Reliability Business, although about a quarter of it is undertaken by other AEA businesses.

4.8 The Department's GNSR programme forms only a small part of the nuclear safety R & D carried out in the UK and worldwide. In addition to the HSE's levy-funded programme mentioned above the nuclear industry carries out a considerable body of R & D in support of safety cases for its plants and work in support of day-to-day operations. A considerable amount of nuclear related research is also carried out by other Government Departments, eg by the Department of the Environment (DoE) through Her Majesty's Inspectorate of Pollution (HMIP), and the Ministry of Agriculture, Fisheries and Food (MAFF) in support of their regulatory responsibilities, and by the Ministry of Defence (MOD) which, as an operator of nuclear sites, is required to operate to safety standards no less stringent than those of commercial operators. The NII also have a small programme of extra-mural R & D, the costs of which are recovered from licensees.

INTERNATIONAL WORK ON NUCLEAR SAFETY

4.9 Internationally, a great deal of R & D is done on nuclear safety. The European Community has a large safety research programme, which is being carried out under the Third Framework Programme. There are also extensive programmes on PWR safety in the USA, Japan, France, the USSR and elsewhere. The International Atomic Energy Agency (IAEA) and the OECD's Nuclear Energy Agency promote expert studies and exchanges of information on nuclear safety issues, although they do not fund safety programmes of their own. In the short and medium term, with any new nuclear plant in the UK almost certain to be of the PWR type, and with growing interest in international convergence of safety standards, the role of international collaborative R & D is likely to increase.

4.10 However, most existing international programmes of research are concerned with the safety of nuclear plant, and so are more relevant to the nuclear industry, and to the HSE's levy funded programme, than to the Department of Energy's GNSR programme. A small amount of work in related areas is being undertaken in the Third Framework Programme and AEA's participation will enable the UK to benefit from the research which other Member States carry out under the programme.

THE DEPARTMENT OF ENERGY'S CURRENT INTERESTS IN NUCLEAR SAFETY R & D

4.11 The Department of Energy has a major interest, as lead Department for civil nuclear emergency planning in England and Wales, in ensuring that the public would be adequately protected from the consequences of an accident at a civil nuclear site. It and the NII both need to have access to information about the safety of overseas nuclear plant, because of the possibility that a nuclear accident overseas could have implications for UK plant. The Department of Energy wishes to collaborate in the field of nuclear safety with the USSR and other countries in Eastern Europe to help minimise the risk of another serious accident in any of these countries. In March 1991, the UK Government issued (together with Belgium, France and Germany) a Joint Declaration on Co-operation on the Peaceful Use of Nuclear Energy. The Declaration stated the intention of its signatories to support Central and Eastern European countries in bringing their nuclear plants to a level of safety comparable with those in the EC member states.

4.12 The Department is not a direct "consumer" for its safety R & D in that it does not generally make direct use of the results of the work it sponsors. For this review, therefore, the Department examined its GNSR programme in consultation with the HSE's NII and Nuclear Safety Research Management Unit (NSRMU), and MOD, which has the major interest in Whitehall in nuclear safety research. Comments were also obtained from MAFF, DoE, and the National Radiological Protection Board (NRPB), whose responsibilities touched on areas covered by the programme.

4.13 The review concluded that a good part of the existing programme, in particular the UK/USSR collaboration, appeared to be relevant to the Department of Energy's objectives as stated in paragraph 4.11 above. However, in the area of environmental consequences there appeared to be some overlap with other Departments' programmes or objectives and the significance of this work for emergency planning purposes was unclear. Its rationale in terms of meeting the

Department of Energy's objectives therefore needed further consideration. There were also some projects on fission product chemistry and aerosol transport, which, it could be argued, might in future be placed in the HSC programme. A more detailed study will now be undertaken, involving other Government Departments, as well as the NII. This study will also consider the scope for future collaboration with other Departments and, where appropriate, with other countries or international agencies. The conclusions of this work will influence decisions on the Department's 1992/93 GNSR programme.

4.14 At present, the entire programme is placed through the AEA and managed by them on the Department's behalf. The review considered that other organisations such as MAFF might make a valuable technical contribution in specific areas, and the possibility of using the NRPB and other contractors should be explored.

4.15 These issues will now be pursued further. The particular interests of the HSE's NII in much of the research was recognised and the HSC's statutory role in advising the Department on safety matters was emphasised. The review concluded that the NII's advisory role needed to be strengthened through its closer involvement in the specification of future programmes. Hitherto, the AEA has played the major role in advising the Department of Energy on its nuclear safety R & D needs. This is no longer an appropriate role for the AEA, as the Department's contractor. While the AEA should continue to play a role in advising on the work which needs to be done, the Department should look to the NII as its principal source of advice in deciding the programme's content. The Department's newly-established Technical Unit (see Chapter 10) would also be able to make a valuable contribution to this process.

THE LICENSING OF FUTURE REACTORS

4.16 The review also looked in detail at future safety research needs. The Department's objectives for the future were twofold:

- The nuclear industry wished to have available the option of purchasing either an existing overseas design of reactor, or, in the longer term, an internationally agreed new design, provided that such a design would be licenseable in the UK and be economic. The Department had the objective of ensuring that the regulatory body, the NII, had the necessary technical underpinning to enable it to address new issues of safety assessment arising from new designs.

- The Department wished to promote greater international convergence of nuclear safety standards leading towards the attainment of higher standards of nuclear safety worldwide.

The review therefore considered the likely options for future reactor orders, and the licensing issues which they would raise.

4.17 Neither the short term option, construction of a replica or near replica of Sizewell 'B', nor the medium term option of the possible purchase of a proven overseas PWR design, would require major new R & D or raise issues relating to NII's capacity to act as an informed regulator. Any R & D related to the safety of such designs could be accommodated within the HSE levy funded programmes or the NII's own extra-mural programme.

4.18 The review recognised that development of any new reactor design, including in general the R & D necessary to support the safety cases for its licensing, would be the responsibility either of the vendor, the prospective licensee, or both (See Chapter Seven). They would in many instances however, need to be able to demonstrate to the licensing body that any R & D which they cited in support of their safety arguments was suitably independent. The NII, for its part, would need to remain fully informed in order to assess evolutionary and revolutionary reactor designs in the future. For this purpose they would continue to need access to a strong, independent research capability. Access to such a research capability would also support the NII in its role of working towards the development of common international safety standards. A continued UK R & D capability would also help give us cost-effective access to relevant work being done abroad. The review concluded that, at present, the AEA seemed best able to provide this technical capability.

4.19 Development in the longer term of an internationally licenseable design, and the move towards greater commonality of safety standards which would accompany it, was likely to bring with it new questions of safety assessment methodology. This would also be true of more advanced designs such as those incorporating passive safety features. The GNSR programme already addressed one aspect of this question - the development and application of probabilistic safety assessment techniques to advanced designs - but a need could emerge to cover several other issues. The review identified a number of areas in which they believed work was likely to be needed; such areas included control and instrumentation, human factors, probabilistic safety analysis, severe accident studies, thermal hydraulics and heat transfer, and reactor physics. This new work would require a substantial increase in funding, which would need to be further considered.

4.20 Although this work would support the capability of the NII to address future licensing issues, the NII does not generally have the power to charge such work to licensees through licence fees because it is not related to specific licence applications. It would be relevant to the Government's objective of keeping open the nuclear option and to the Department of Energy's objectives for a future regulatory framework, and so seemed a possible candidate for Department of Energy funding. Nevertheless, as it was in industry's interests to ensure that the NII was well-placed to respond quickly and effectively to future licensing issues, there was a case for their contributing. Industry involvement would also help ensure that the programme was well focussed. The review concluded that this issue should be further discussed with industry and the HSE to explore the extent to which this work can be taken forward in conjunction with the HSE programme, possibly as part of the HSE's approach to maintaining a capability in key technical areas.

CONCLUSIONS

4.21 The review reached the following conclusions on the Department's GNSR programme:

(i) The Department should continue to fund a programme of nuclear safety research in support of its policy objectives in this area. It should look to the NII to act as its principal adviser on the content of the programme, which should include research in support of the NII's future regulatory work which could not be funded by means of levy.

(ii) Other Departments, notably MAFF, DoE and the HSE's Nuclear Safety Research Management Unit, should be involved, with the NII, in drawing up the programme. The Department should have the final say about the size and content of the programme.

(iii) The UK/USSR collaboration funded by the programme should make a useful contribution to international efforts to support Central and Eastern European countries in bringing their nuclear safety standards up to those of EC Member States. The work is in the long term interests of the UK's own nuclear energy programme and is thus appropriate to Department of Energy funding. However, means of reviewing the effectiveness of the programme, and of co-ordinating the UK's efforts with those of other countries, should be established.

(iv) A start should be made immediately through the machinery proposed in (ii) above on examining the balance and rationale of individual elements of the programme; the scope for collaboration with other interested Departments; the possibility of using contractors other than the AEA for parts of the programme; and on whether it would be appropriate to transfer any parts of the work to the HSC's programme.

(v) Work on the safety features of advanced reactor designs should be broadened to include essential projects in support of the NII's future licensing needs. A start should be made in 1992/93, and the priorities discussed as a matter of urgency between the NII, HSE, and the Department. The industry should also be asked for its views. The funding implications, and the respective roles of the Department, through its GNSR programme, and of industry, through the HSE programme, would need to be considered.

QUESTIONS

4.22 Comments are invited on the following questions:

(i) Should the Government or the nuclear industry fund R & D undertaken to support the regulatory authorities in addressing licensing issues relating to future designs of reactor, given that such designs are not currently the subject of UK licensing procedures?

(ii) The GNSR programme is currently placed entirely with the AEA. Are there other R & D contractors with the necessary expertise to undertake work in the programme?

(iii) Are there any significant R & D issues relating to the Department of Energy's interests as distinct from those of the industry which it would be appropriate to fund under the GNSR programme ?

CHAPTER FIVE: RADIOLOGICAL PROTECTION RESEARCH

INTRODUCTION

5.1 The acceptability of nuclear power in the UK is critically dependent on understanding the risks associated with low-level radiation and on the public perceptions of these risks. Concern about dangers from ionising radiation has come increasingly to the fore over the years as nuclear power has developed. This issue is certain to continue to figure significantly in discussions on the future of the industry and the part it has to play in energy supply. It is against this background that the Review considered the level of radiological protection research (RPR) in the UK and the range of objectives of the various organisations involved. The work currently supported by the Department of Energy, its aims and objectives, was considered within this perspective.

5.2 The review looked at the full range of RPR work in the UK which could conceivably be of relevance to the nuclear industry. This embraces all research whose aim is to improve the understanding of the action of ionising radiation on biological systems, including that research whose primary objective is not directly related to the operations of the nuclear industry.

RADIATION PROTECTION RESEARCH IN THE UK

5.3 It is important to put the Department of Energy's contribution to radiological protection research in the UK into the wider context. Total annual expenditure on RPR in the UK by Government Departments, Research Councils, industry and other bodies exceeds £21 million. The Department of Energy's programme accounts for less than 3% of this total.

5.4 For RPR work in the UK four sets of objectives can be identified (expenditure figures are for 1990/91):

- work funded by industry in support of its commercial objectives or directed towards particular issues, ie. Nuclear Electric plc, Scottish Nuclear Ltd. and BNFL. Total expenditure £4,300,000.

- work funded by bodies with regulatory, administrative and/or advisory responsibilities, ie. the Departments of Health and the Environment, MAFF, Her Majesty's Inspectorate of Pollution, the Nuclear Installation's Inspectorate and the National Radiological Protection Board. Total expenditure £9,900,000.

- basic research, ie. the Medical Research Council, the Natural Environment Research Council and the UK Coordinating Committee on Cancer Research. Total expenditure £7,300,000.

- work commissioned to support decision-making on the long-term future of the nuclear industry, ie. the Department of Energy (£560,000), AEA Technology (£300,000) and a proportion of the work supported by the nuclear industry.

5.5 This range of objectives is not unique to the radiation or nuclear field and occurs in many other industries including, for example, chemicals and food. While the Department of Health naturally has overall responsibility for matters affecting health, it normally works on specific topics with the Department most closely connected with the industry concerned, particularly on matters affecting occupational health.

5.6 Radiation protection work in the UK includes a series of epidemiological studies on the role of radiation and chemicals in the incidence of cancer, in particular leukaemia, in different sectors of the population. There is a high level of cooperation on these studies by all parts of the nuclear community. The Department of Energy does not fund any of this work but it maintains contact with it through membership of advisory bodies and coordinating committees.

5.7 As part of their five-year (1990/94) programme of research in the field of nuclear fission safety the European Community supports research in Member States on radiation protection. Total funds available for this are 29 mecu (£21 million). On the basis of past experience, around £3.7 million of RPR work funded by the Commission may be undertaken in the UK over the five year period.

DEPARTMENT OF ENERGY'S RPR PROGRAMME

Background

5.8 Prior to the establishment of the Trading Fund in 1986 the radiation protection programme at the Atomic Energy Authority was a single programme funded from the Atomic Energy Vote. With the establishment of the Trading Fund Government Departments assumed funding responsibility for those parts of the programme they considered to support their objectives, the work remaining with the Authority. The Department of Energy programme continued largely to be formulated by the AEA. At the same time industry was invited to contribute to the programme which became known as the Core Programme.

Present Position

5.9 To date all the Department's funding for RPR has been placed with AEA Technology through their Environment and Energy business arm. For the year ending March 1990 this constituted some 15% of a £4 million programme of work supported at the Authority by the Department of the Environment (12%), the Department of Health (26%), MAFF (13%), Nuclear Electric (10%) and BNFL (12%) as well as the Department of Energy.

5.10 Currently work in the Department of Energy's RPR programme addresses four areas:-

- radiation effects
- radiation dosimetry
- environmental radioactivity
- accidental dispersion

Detailed aims of the work are set out in paragraphs 5.12 to 5.17 below. It should be noted that the Department has no direct administrative or regulatory responsibility in the field of radiological protection.

5.11 In 1986/87 the Department of Energy's funding for RPR was £210,000. This had increased to £560,000 by 1990/91 mainly as a result of a higher priority being given to the work as a consequence of the Chernobyl accident. The Department's funding will decline to £457,000 in 1991/92 as a result of the transfer to the Department of Health of work on radiation and man which was considered to be more appropriate to their objectives. The Department maintains its links with this transferred work through liaison with the Department of Health; indeed some projects are jointly funded. A small programme of work in this area is also maintained by the Department specifically related to radiation risks in the industrial environment, an area not fully covered by the Department of Health.

RATIONALE FOR THE DEPARTMENT OF ENERGY'S RPR PROGRAMME

5.12 The Government's policy of maintaining the nuclear option means that it is essential to address remaining uncertainties about radiation risks and to ensure that decisions about the nuclear industry can be taken on the basis of the fullest possible information. The Department of Energy therefore needs to be able to assess the effects of technical progress and of any specific events affecting the industry, and to be confident that any necessary research is carried out. Most of such research is carried out by industry or other bodies, but there are some areas not currently included in those organisations' research programmes, where the Department believes work is needed and which it is therefore funding.

Radiation Effects

5.13 There remain uncertainties in the extrapolation of the observed results of high radiation doses to those expected for low doses. This leads to consequential uncertainties about industrial risks. The objectives of research on radiation effects are to improve the estimates of radiation risks from exposure and to develop a better understanding of the relative biological impact of the different types of radiation. The Department's particular interest is in ensuring that in more general research funded by Government on low level radiation effects, the particular interests of workers in the nuclear industry are properly taken into account.

Radiation Dosimetry

5.14 The increasing stringency of radiation protection standards gives rise to problems with radiation dosimetry. The Department has an interest, with the regulators, in ensuring proper protection for workers in the nuclear industry, whilst also ensuring, with the industry, that solutions to radiation dosimetry problems are available, so that the future development of the nuclear industry is not impeded.

Environmental Radioactivity

5.15 The aim of research in this area is to establish an improved factual basis for the assessment of dose from discharges, so that the restrictions on discharges can be set reflecting the factual position. This involves the validation of environmental models and the development of a greater understanding of the mechanisms of radionuclide migration. Other organisations, including industry, are undertaking work in this area and this needs to be taken into account by the Department of Energy in considering funding research in this area.

Accidental Dispersion

5.16 The aim of research in this area is to ensure that adequate quantitative methods are available to detect, assess and respond to nuclear accidents in the UK. The research carried out by the Department of Energy in this area is complementary to, and takes account of, studies on the prediction of accident consequences in the GNSR programme.

Objectives

5.17 The Department's objectives can be summarised as:-

(i) to improve knowledge of the dose-response relationship in occupational exposure ranges and of the radiation risks associated with the industrial environment. This will reduce the current uncertainty in extrapolating the effects of radiation into the dose range of occupational concern.

(ii) to ensure that adequate methods of estimating radiation doses are available for likely future regulatory requirements.

(iii) to reduce the uncertainties in the quantitative description of the environmental pathways by which routine and accidental discharges of radionuclides reach man. This definition of the radiological pathways will assist in assessing the impact of industrial discharges on man and will contribute to the body of information used in the establishment of realistic control procedures.

CONCLUSIONS

5.18 Nearly all the major customers for radiological protection research in the UK, including both Government Departments and the nuclear industry, took part in the review of the Department's RPR programme.

5.19 The review concluded:

(i) There is a need for the Department to develop greater knowledge and understanding of problems facing the nuclear industry related to radiological protection. Until recently the Department has relied on the AEA for that expertise. This is not appropriate in a customer/contractor relationship. Increased expertise in the Department of Energy is essential whatever the level of research it supports. The establishment of the Department's Technical Unit (see Chapter 10) should help to bring this about.

(ii) The Department should have the capability to decide whether there is a need for radiological protection research not currently undertaken by other bodies and, if so, how this work is best carried out.

(iii) The Department's RPR programme constitutes a distinct suite of research projects which contribute to the Department's overall objectives and which do not replicate work funded by other bodies.

(iv) The Department's programme, though small, benefits from its close association with other RPR work at the AEA. This is a factor which must be taken into account by the Department when considering using other contractors. This does not, however, preclude work being placed elsewhere; value for money and cost effectiveness are the key criteria.

(v) Greater understanding of developments in RPR, their potential impact on the nuclear industry, the identification of Department of Energy needs for RPR and the consequent development of an effective programme of research can only be achieved in close liaison with other organisations. Participation in the larger AEA managed programme helps to achieve this, but closer contact is needed with other organisations undertaking research in this area, eg. industry, the NII, the HMIP and the NRPB.

(vi) The current level of funding for the programme allows it to address a worthwhile number of specific problems not addressed by other research programmes and other bodies and gives the Department an entree to the research network which is important to the Department's overall appreciation of developments in the radiological protection area.

5.20 The review therefore recommended that:

(i) the Department should become a better informed customer of the work it is funding and should develop closer relations with other bodies funding work in this area. This will enable the Department to assess more clearly what work it should be funding in RPR to meet its particular objectives, how much it should spend and whether identified research needs are better funded directly or as part of other organisations' research programmes.

(ii) the Department should keep its existing RPR programme under review and in particular should consider:-

a. whether its objectives can be properly met through other research programmes given the large number of organisations involved in RPR work in the UK; and

b. whether it is appropriate to fund research directly or to transfer resources to more expert research-commissioning organisations, consistent with the Department's objectives being met.

QUESTIONS

5.21 The Department would welcome comments on the following questions:-

(i) Could the Department's radiological protection objectives be met without the need for a Department-funded research programme?

(ii) Are the current aims of that programme appropriate?

(iii) More generally, is the overall level of RPR funding in the UK appropriate ? Could more effective results be obtained by more closely targeted and co-ordinated programmes ?

CHAPTER 6: SAFEGUARDS

6.1 The Government has a legal obligation to ensure that nuclear materials are used and controlled in accordance with the Euratom Treaty and to its commitment under the Non-Proliferation Treaty (Annex A to this Chapter). In addition, the internal control and management of nuclear materials in the UK must be such as to ensure that nuclear materials do not fall into unauthorised hands or create a radiation hazard to employees or the public.

6.2 Public opinion both in the UK and in other countries needs to be assured that States with civil nuclear power programmes are not using them to manufacture nuclear weapons. This depends on the existence of an effective, efficient and credible safeguards system developed in conjunction with and monitored by international agencies. UK activities are coordinated by the Safeguards Office of the Department of Energy, which has also established a programme of research as part of the UK's contribution to the development and implementation of safeguards. The programme is undertaken in support of the International Atomic Energy Agency (IAEA), (currently about £1 million a year), and related activities to underpin the implementation and development of safeguards in the UK (currently about £0.4 million a year). In addition to the Government funded R & D programme, the UK nuclear industry devotes substantial resources to ensure nuclear plants are engineered in such a way as to make them intrinsically safeguardable.

HISTORICAL DEVELOPMENT

6.3 During the 1970s, there was a large expansion in the number of nuclear facilities to be safeguarded and new methods were needed to deal with the problems raised. The IAEA had, and still have, neither the facilities nor the funds necessary to carry out safeguards research and development needed to keep pace with advances in the nuclear fuel cycle and to optimise the cost of implementing safeguards. It was decided that rather than increase the Agency's resources, the R & D should be done by Member States through voluntary programmes. The UK programme was initiated by the Department of Energy in 1981 and it is now one of fourteen support programmes operated by Member States to assist the IAEA. The UK Support Programme is reviewed at Steering Committee Meetings which are chaired by the Department of Energy, with representatives from UKAEA, BNFL, IAEA, Euratom and the Joint Research Centre (JRC), Ispra. This review gives the UK the opportunity to influence the research programmes which will determine the international authorities' approach to safeguards, especially in those areas of commercial interest to the UK or where there is a particular proliferation concern. R & D related to Euratom safeguards is organised rather differently, the major part of the effort being concentrated at Ispra and funded by the European Commission. Improving the cost effectiveness of international safeguards has a direct benefit to the UK since we contribute directly to the cost of safeguarding activities through the budgets of the IAEA and Euratom.

OBJECTIVES

6.4 The objectives of the Safeguards Programme Letter are:

(i) to assist the IAEA in the attainment of its safeguards goals in a cost-effective manner and to influence the formation of technical policy in the Agency to achieve both efficiency and credibility;

(ii) to assist the UK in meeting its obligations under the Non-Proliferation Treaty, the Euratom Treaty, and associated Agreements in as cost effective a manner as possible, both for existing facilities and those at the design stage;

(iii) to assist the UK in formulating its own ideas to enable it to make informed contributions to IAEA discussions;

(iv) to assist the Safeguards Office in the coordination, development and implementation of Government policy and international practices regarding nuclear materials control;

(v) to undertake R & D as requested by or agreed with the Department of Energy on more sensitive subjects which would not be suitable for inclusion in the programme for the IAEA.

Detailed technical objectives have been set for the current R & D Programme.

BENEFITS AND COSTS

6.5 The results of the R & D assist the IAEA to discharge its safeguards duties effectively, with minimum intrusion in plant operation and at minimum cost. It is difficult to quantify the precise value of this benefit, but it is certain that without Member States' support the IAEA could not continue to function effectively in its Safeguards remit and, in particular, to design safeguards approaches for new facilities incorporating technological advances.

6.6 The research also allows the UK to meet its own safeguards obligations: access to up-to-date research information is essential if balanced and informed judgements are to be made about the introduction of new safeguards arrangements.

GOVERNMENT RESPONSIBILITIES

6.7 It would not be appropriate to require the nuclear industry to fund this research since it stems from a broad foreign policy and security objective (preventing the proliferation of nuclear weapons). There is a firm political requirement to support safeguards not only to regulate UK industry but also to be seen to play our part in developing an effective international non-proliferation regime.

6.8 Technical expertise on safeguards lies in the Department of Energy, as does the responsibility for the development of IAEA technical policy. The research undertaken in support of these responsibilities is therefore administered by this Department. The Foreign and Commonwealth Office takes the policy lead in Whitehall on non-proliferation matters and contributes to the formulation of the safeguards R & D programme.

IMPLEMENTATION

6.9 The Department of Energy's safeguards research programme operates on a one year cycle; it is a rolling programme formulated on the basis of future needs as seen by the IAEA and the UK, taking into account, among other things, the development of new, high technology nuclear plant, increasing automation and more extensive use of computers in modern nuclear plant, and the need to reduce the radiation dose uptake of inspectors and operators involved with safeguards activities. Attention is focussed on areas where the UK has demonstrated a particular strength, such as: uranium enrichment monitoring, Near Real Time Materials Accountancy, destructive/non-destructive assay measurement of nuclear materials, the verification of tamper-resistant seals and systems studies.

Role of the AEA

6.10 The Department of Energy uses the AEA to undertake this research, because of its expertise in this field and because of the sensitivity of some of the work. Much of the work involves laboratory studies requiring access to special nuclear materials (eg, significant amounts of plutonium) and associated specialised handling facilities. It would not be sensible to invite bids to undertake such research from organisations which are known not to possess appropriate active handling facilities. A further consideration stems from the specialised nature of safeguards, and the need to maintain a small core of expertise within the UK to respond to requests for support and advice by the Department. Other constraints such as security considerations (both physical and the protection of classified information) have to be borne in mind. However, notwithstanding the above, opportunities will continue to be sought to allow certain projects (eg specialised review studies) to be contracted or sub-contracted to other organisations.

6.11 As indicated earlier, BNFL has been very helpful in providing specialist advice to the safeguards support programme and has provided access to specialised facilities for training and equipment testing. It should also be noted that the Company has devoted considerable resources to the development of safeguards related systems and instrumentation; and, through international symposia and publications, made a substantial contribution to the international debate on safeguards methodologies.

Co-ordination with EC research undertaken for EURATOM

6.12 The development of techniques and equipment in support of EURATOM Safeguards is provided separately by research undertaken by the JRC, Ispra in a CEC funded programme. UK oversight of the JRC programme is provided through the normal EC administrative system for research management. The JRC itself carries out an R & D programme for the IAEA, and is also involved in joint programmes with others, for example, the USA. The European Safeguards Research and Development Association (ESARDA) - an association of European organisations formed inter alia to harmonise R & D for safeguards - plays an important role in facilitating the effective co-ordination of research between EC Member States, the JRC and R & D support programmes provided for the IAEA.

Longer Term Programme Trends

6.13 As a result of the international consultations with the IAEA and other contributing States the UK Support Programme has in the past concentrated on safeguards of the Fast Reactor and its fuel cycle, centrifuge enrichment plants and nuclear material in storage both as spent fuel and purified product. Current research activities focus particularly on the safeguarding of large scale reprocessing plants.

6.14 In the medium to long term, safeguards R & D is likely to continue to be dominated by the needs of fuel reprocessing as safeguards systems are defined for larger throughput plants such as THORP, the Rokkasho-mura reprocessing plant in Japan, and MOX fuel fabrication facilities in the UK and overseas. Safeguards for new enrichment processes, such as laser isotope separation, will need considerable attention. The monitoring of hold-up of fissile material in plant components also seems likely to require further research effort.

6.15 The number of facilities coming under IAEA safeguards will continue to grow over the coming years; this is likely to result in a corresponding increase in demand for R & D support.

NUCLEAR MATERIALS CONTROL SUB-PROGRAMME

6.16 Beside the main R & D programme for the IAEA, the Safeguards Programme Letter provides funds (approx. £0.4 million/year) covering advice and assistance given to the Department by the AEA's Nuclear Materials Control Office (ANMCO) on safeguards, nuclear materials control and accountancy, and classification matters. Part of the support provided relates specifically to safeguards research and development and its effective co-ordination. To this end, work is undertaken to:

- seek to make ESARDA more effective;

- provide experts on safeguards and on nuclear materials accountancy and control to participate in the IAEA Advisory Group Meetings and Consultants' Meetings on behalf of the UK;

- provide R & D on safeguards matters which, for one reason or another, it is not appropriate to provide through the IAEA programme;

- carry out studies to assist in the establishment of Government policy on safeguards.

CONCLUSIONS

6.17 The review concluded that:

(i) the safeguards R & D programme supports the achievement of clearly defined objectives in support of Government policies. It is right for Government to fund this programme;

(ii) the safeguards R & D programme should continue to be funded and managed by the Department of Energy;

(iii) the safeguards R & D programme has a clearly defined rationale, appropriate technical aims and justification, and associated prospective benefits; it is managed in accordance with accepted administrative procedures. The Department of Energy, through its Safeguards Office, is a fully informed customer of R & D commissioned in the field of safeguards;

(iv) The IAEA has established mechanisms to identify and set priorities for research needs on safeguards and the coordination of safeguards R & D world-wide is well-managed. Proper management and coordination of these international activities will continue to be important in the future.

QUESTIONS

6.18 Comments are invited on the following questions:-

(i) Is the size of the programme right given the priority attached to safeguards ?

(ii) Are the objectives of the programme right ?

(iii) Can the coordination of safeguards R & D be further improved?

ANNEX A

THE UK's SAFEGUARDS OBLIGATIONS

IAEA SAFEGUARDS

1. The UK has been an active member of the International Atomic Energy Agency (IAEA) since it was established in 1957. A key article in the statute of the IAEA states that it is authorised "to establish and administer safeguards designed to ensure special fissionable and other materials, services, equipment, facilities and information made available by the IAEA or at its request or under its supervision or control are not used in such a way as to further any military purpose and to apply safeguards at the request of the parties, to any bilateral or multilateral arrangement or at the request of a State, to any of that State's activities in the field of atomic energy". The administration of IAEA Safeguards in the UK, as in other States, is based on formal Agreements (INFCIRCs), with implementation arrangements defined in Subsidiary Arrangements including Facility Attachments (FAs) negotiated by the Safeguards Office.

2. The UK signed a trilateral Safeguards Agreement with Japan and the IAEA in 1968 (INFCIRC 125), and a bilateral Agreement with the IAEA in 1972 (INFCIRC 175) so that IAEA Safeguards could be applied to irradiated fuel imported into the UK. In the late 1960s the UK was active in the preparation of the Non-Proliferation Treaty (NPT). This came into force in 1970.

3. The UK announced its intention of allowing IAEA inspection of its civil nuclear facilities in 1968. This was to demonstrate, inter alia, that we enjoyed no commercial advantages over non-nuclear weapon states. The UK/Euratom/IAEA Safeguards Agreement (INFCIRC 263) came into force in 1978. Under this Agreement all civil nuclear material in facilities is reported via Euratom to the IAEA

and the Agency are free to designate facilities for inspection.

THE EUROPEAN COMMUNITY

4. The UK entered the EEC in 1973 and became subject to Euratom Safeguards under the Euratom Treaty and in 1976 to the detailed provisions of Euratom Regulations 3227/76. The overall objective of Euratom Safeguards is to allow the European Commission to satisfy itself that in territories of Member States:

(a) ores, source materials and special fissile materials are not diverted from their intended uses as declared by the users; and

(b) the provisions relating to supply and any particular safeguarding obligations assumed by the Community under an agreement concluded with a third state or an international organisation are complied with.

The main agreements covered by (b) above are the nuclear supply agreements between Euratom and the main supplier States (Australia, Canada and the US).

5. All civil nuclear material in the UK is subject to Euratom reporting and inspection procedures. Facility specific arrangements are agreed in 'Particular Safeguards Provisions' (PSPs).

CHAPTER SEVEN: REACTOR TECHNOLOGY (INCLUDING THE FAST REACTOR)

7.1 This chapter considers what R & D the Department should sponsor in support of reactor technology.

THERMAL REACTORS

PRESENT POSITION

The International Scene

7.2 In December 1990 there were over 420 nuclear power plants operating throughout the world, supplying about 16% of the world's electricity generation. The most common types were the Pressurised Water Reactor (PWR) which accounted for 63% of installed capacity followed by the Boiling Water Reactor (BWR) which accounted for over 22%. The tables at Annex A to this chapter provide more detail on the nuclear industry worldwide.

7.3 The USA, France, Germany and Japan accounted for nearly 64% of total world nuclear capacity. In the USA, there have been no new nuclear orders since before the accident at Three Mile Island in 1979, though the US Government hopes nuclear power might generate 21% of US electricity in 2030 if the measures proposed in its 1991 National Energy Strategy are implemented. More than 70% of generating capacity in France is now nuclear and Electricite de France have reaffirmed their intention to order a new 1400 MW PWR at Civaux in late 1991.

7.4 No new reactors are under construction in Germany. On 30 May the German electricity utilities announced that they would no longer be making licence applications for the construction of two new PWRs at Stendal and Greifswald in what was formerly East Germany. Japan is considering plans for a major expansion of nuclear power. In June 1990 an Advisory Committee to the Japanese Ministry of International

Trade and Industry (MITI) called for an increase of nuclear capacity from its current level of 30 GW to 72 GW by 2010.

7.5 At the beginning of the next century, many countries will need to take decisions about replacing their existing stock of reactors. Annex A shows that, on the basis of an assumed 30-year life, 162 reactors would be due to be retired between 2000 and 2010 (69 reactors on the basis of a 40-year life). The prospect of these decisions is starting to influence planning by utilities, particularly in France.

Position in the UK

7.6 The UK nuclear industry is considering several reactor options for possible ordering in 1994 and beyond, in the event that the 1994 Review decides in favour of further nuclear orders. In the short-term (1994-1996), there is the possibility of building Hinkley C as a Sizewell replica, perhaps with design changes to improve its competitiveness.

7.7 Beyond Sizewell B variants, there is the prospect of reactors and designs which are being developed overseas or on an international collaborative basis. In all cases, the nuclear industry has made it clear that it will not be prepared to order reactors of a new design which have not had experience at the prototype stage.

Reactor Vendors

7.8 Annex A shows there are many different suppliers of reactors worldwide - Westinghouse, Framatome, Siemens, ABB, General Electric (of the US), Mitsubishi, and others. International collaboration is becoming increasingly important in helping to spread development costs, and a number of important international groupings have been established such as: -

(i) the joint venture set up in April 1989 between Kraftwerk Union AG (KWU), a division of Siemens AG, and

Framatome SA of France called Nuclear Power International (NPI). This agreement covers the sale and service of nuclear steam supply systems, nuclear islands and complete plants. They are working on a new PWR design which would be licensable in both countries;

(ii) the merger of ABB (Asea Brown Boveri) and Combustion Engineering;

(iii) the collaboration of Westinghouse and Mitsubishi in the design of the 1300 MW Advanced Pressurised Water Reactor (APWR); and

(iv) the collaboration on the Safe Integral Reactor (SIR) between the AEA, Rolls Royce, Stone & Webster and Combustion Engineering.

7.9 There is also considerable cooperation amongst utilities. Nuclear Electric, for instance, has signed an agreement with Electricite de France (EdF) to collaborate on their REP2000 programme to assess future reactors. Other overseas utilities are also participating in this project.

7.10 NNC Ltd is the UK licensee of Westinghouse for its PWR technology, and has formed a joint company with Westinghouse as the vehicle for the transfer of the technology.

Rationale for Department of Energy funding

7.11 The Department of Energy is not at present providing any funding towards the development of thermal reactor technology. Government policy is that industry-orientated R & D should normally be funded by the beneficiaries of that R & D. They are best placed to know what R & D is required and whether it is cost-effective.

7.12 There are a number of considerations which might justify Government intervention in this area. These are:-

(i) Wider Interests

The actions of individual firms may yield social benefits for which the firms secure no commensurate return. In the case of nuclear power, for instance, this might lead potential investors to pay insufficient attention to strategic considerations, such as the environmental advantages of nuclear power or its contribution to diversity (and thus) security of supply.

Timescales can influence the willingness of a commercial organisation to support R & D. The further away the prospect of commercial returns, the less willing might commercial organisations be to devote significant resources to R & D. If they are not prepared to do so, and the Government judges that such R & D should be undertaken for strategic reasons, Government support may be necessary if such work is to take place, with funding being transferred to industry as the prospect of commercial returns approaches.

(ii) Inadequate information

Inadequate information may lead to a misallocation of resources. Potential investors might have insufficient information to judge whether to spend money on R & D and, if so, how much.

(iii) Risk

Risk aversion on the part of potential investors may sometimes not be overcome by suitable capital market mechanisms. In the case of nuclear power, this would distort the market if the very high capital costs of designing and building reactors - and the lengthy timescale (given the probability of a public inquiry) before a return can be obtained - were to constitute a barrier for the individual firm or utility.

Paragraphs 7.13 to 7.20 below consider whether the Department of Energy should fund the development of reactor technology against these criteria.

Existing Reactors

7.13 R & D can reduce costs and improve the performance of existing nuclear reactors in the UK. Nuclear Electric, SNL, and BNFL as the beneficiaries of such R & D are best-placed to assess its costs and benefits and to commission and undertake it. The review did not identify any externalities, lack of information or risks in this work that justified funding of such R & D by the Department of Energy.

Future Reactors

7.14 Nuclear Electric is currently undertaking R & D in a limited number of areas aimed at improving the competitiveness of a follow-on plant to the Sizewell B reactor. The R & D is mainly directed at enhancing performance and at improved construction methods. Nuclear Electric has a direct interest in the design and is therefore best placed to improve it.

7.15 Vendors of nuclear power stations (such as the Swedish-Swiss company ABB, Siemens in Germany, Framatome in France, General Electric and Westinghouse in the USA and Mitsubishi in Japan) are already devoting major resources to the development of reactor types which might become commercial over the next two decades. These companies are backed by substantial capital and have access to capital markets which enable risks to be borne by equity shareholders who can minimise their risks by spreading them over a wide portfolio. Reactor vendors are also exploiting the possibilities of international collaboration as a means of spreading development costs (see paragraph 7.8 above) and utilities in Europe are working towards closer coordination of their specifications. This suggests that the normal commercial incentives have already stimulated development work on existing commercial designs. The review concluded therefore that there was no case for Department of Energy funding for R & D on the development of future conventional reactors.

7.16 The benefits of replication could be achieved by building the same design of reactor in a number of different countries. For this to work in Britain, the regulatory body, the NII, would have to be able to license a foreign design, ideally through collaboration with other regulators. The Department of Energy is beginning to explore how such cooperation could be achieved. There would also have to be collaboration between the utilities and, possibly, collaboration on any R & D that was needed to support the work. The Department has an important role in ensuring that the NII has the necessary technical underpinning to enable it to address new issues of safety assessment arising from existing overseas reactor designs or, in the longer term, from any design being developed through international collaboration. Closer collaboration between regulators and greater understanding of approaches to safety taken in different countries should promote greater international convergence of safety standards. The Department wishes to encourage this process which should lead to the attainment of higher standards of nuclear safety worldwide. Chapter Four of this Document suggests how R & D might help to achieve these objectives.

7.17 The possibilities offered by Small and Medium-Sized Reactors (SMRs) have been the subject of much discussion and speculation. Although SMRs may lose the benefits of economies of scale, their proponents claim a number of offsetting factors, such as:-

(i) easier financing, since the capital costs of SMRs would be lower, and an earlier revenue stream;

(ii) a close match to the need to meet demand - a utility could build up capacity in smaller increments; and

(iii) because they are smaller, the opportunities for factory fabrication should be greater, and this should improve the prospects for quality control.

7.18 These designs are of interest to utilities in the longer term. The economics of their replication cannot be assessed unless and until one or more utilities undertake series-ordering. A number of SMRs claim inherent or passive safety features, but the designs have not yet been given detailed attention by the safety authorities.

7.19 The Department of Energy has taken the view that - in the absence of any evidence of market distortion - it should be for the industry to fund the development of small and medium-sized reactors. The lead role should be for the reactor vendor, who stands to gain the most through profitable sales, possibly with involvement by the utilities who would operate such reactors. Ministers have made clear that the involvement of the AEA (with Rolls Royce Associates, Stone & Webster and Combustion Engineering) in the development of the Safe Integral Reactor (SIR) is a commercial venture on their part.

7.20 The review considered this approach against the criteria for Government intervention discussed in paragraph 7.12 and confirmed that the funding of reactors such as SIR should be for the reactor vendor, with some possible involvement from the utilities.

THE FAST REACTOR

Present Position

7.21 R & D on the fast reactor worldwide has generally been funded by Governments with, on occasion, some utility funding at the margins. (Further details are provided in Annex B to this Chapter). This is because the timescale for the commercial deployment of the fast reactor is much more distant than for thermal reactors. Its proponents argue that its introduction into electricity supply systems which already have a large thermal reactor component would provide utilities with a virtually limitless supply of fuel. The UK has been developing the fast reactor since the early 1950s and has spent over £4 billion (in 1988/89 money) on its development. The Department of Energy is currently funding the operation of the Prototype Fast Reactor (PFR) at Dounreay and is involved in the European Fast Reactor (EFR) collaboration.

The Prototype Fast Reactor (PFR): Rationale for Department of Energy funding

7.22 The key question for the UK Government is what is the most cost-effective way to enable the UK to be in a position to use fast reactors as and when they are needed. It seems unlikely that the capital cost of a fast reactor could be reduced substantially below that of a thermal reactor, so long as a secondary sodium circuit is regarded as essential to the fast reactor design. It follows that the economic case for the fast reactor would have to rest on a significantly lower fuel cost, bearing in mind that fuel cycle costs are a much smaller proportion of total generating costs than capital costs for both thermal reactors and fast reactors.

7.23 There is now less concern about the provision of uranium supplies than there was 10-15 years ago. Large new deposits have been found and the predicted growth in nuclear-generated electricity has not occurred. Were there to be a significant increase in nuclear-generated electricity worldwide, and the price of uranium began to rise, one would expect increased exploration activity, in line with past experience (and as was the case, for example, in the oil and gas industry after the price rises of the early and later 1970s).

7.24 The OECD/NEA Red Book on uranium supplies gives evidence to conclude that there is sufficient uranium for 75 - 175 years' supply at the rate of use projected for 1995. Assuming 10 years for planning and construction, there is unlikely to be a need for commercial ordering for the fast reactor for at least 30 years, using the lower figure of "endurance" of uranium supplies.

7.25 In 1988 the Government carried out a review of the fast reactor programme in the light of its expectation that commercial deployment of fast reactors in the UK would not be required for 30 to 40 years. Following this review, the then Secretary of State for Energy announced on 21 July 1988 that the Government wished to retain a position in the technology at economic cost and that it would continue to fund a "core" R & D programme of £10 million a year to provide the basis for continuing collaboration with our partners in the EFR collaboration. The Secretary of State also made clear that the Government had decided to fund the PFR at Dounreay until the end of the financial year 1993/94; and to fund the reprocessing plant at Dounreay until 1996/97 so that it could reprocess spent fuel from the reactor. Last July the Commons Energy Select Committee endorsed the Government's decision to cease funding PFR after March 1994.

7.26 The operations of the Dounreay plants cost about £48 million a year, net of PFR electricity sales to Scottish Hydro of £12 to 14 million a year.

The European Fast Reactor Collaboration: Rationale for Department of Energy funding

7.27 The UK is collaborating with France and Germany on R & D and design work associated with the development of a European Fast Reactor. The UK, like its partners, has taken the view that the costs of development are more sensibly met - and national contributions reduced - if the work is shared between a number of partners rather than by means of a series of national programmes which may duplicate research effort. The total R & D budget for EFR in 1991 is 91 MECU (about £ 64 m), to which Germany, France, and the UK are contributing 39, 37 and 15 MECU respectively. Annex C to this chapter gives further details about the collaboration.

7.28 It is Government policy that the utilities and not Government should fund the UK's contribution towards the design work for EFR which is being done under the "Concept Validation Phase". This costs around £25 million a year of which the UK contribution is about a third.

7.29 The design work and the £10 million "core" R & D programme funded by the Government provide the basis of the UK's continuing collaboration in the EFR, together with lessons derived from the operation of PFR. The next decision-point in the EFR timetable is 1993, when the Concept Validation Phase is due to end. At that stage the UK - along with the other partners - will want to review what the design work has achieved and to measure it against expectations of fast reactor deployment.

CONCLUSIONS

7.30 The above analysis suggests the following conclusions:-

(i) funding of R & D on existing thermal reactors should be for their operators - Nuclear Electric, SNL and BNFL;

(ii) Nuclear Electric are best placed to fund R & D to improve the competitiveness of a Sizewell-B type follow-on plant;

(iii) funding of R & D on new reactor designs should principally be for the vendor, probably with some support from potential customers. (Chapter 4 of this Document concluded that work on the safety features of advanced reactor designs should be broadened to include essential projects in support of the NII's future licensing needs);

(iv) on the fast reactor, the review confirmed that that the Department of Energy should not fund the operation of PFR beyond March 1994.

QUESTIONS

7.31 Comments are invited on the following questions:-

(i) Are the conclusions in paragraph 7.30 appropriate ?

(ii) What is the best way to enable the UK to use fast reactors as and when they are needed ? Does continuing international collaboration make sense or would it be preferable to license the technology at the appropriate time ?

(iii) What is the appropriate level of Department of Energy spending on fast reactor technology, given that commercial deployment of a fast reactor in the UK is unlikely for 30 to 40 years at the earliest ?

(iv) Is there any scope for improvement in the work of the EFR collaboration ?

ANNEX A

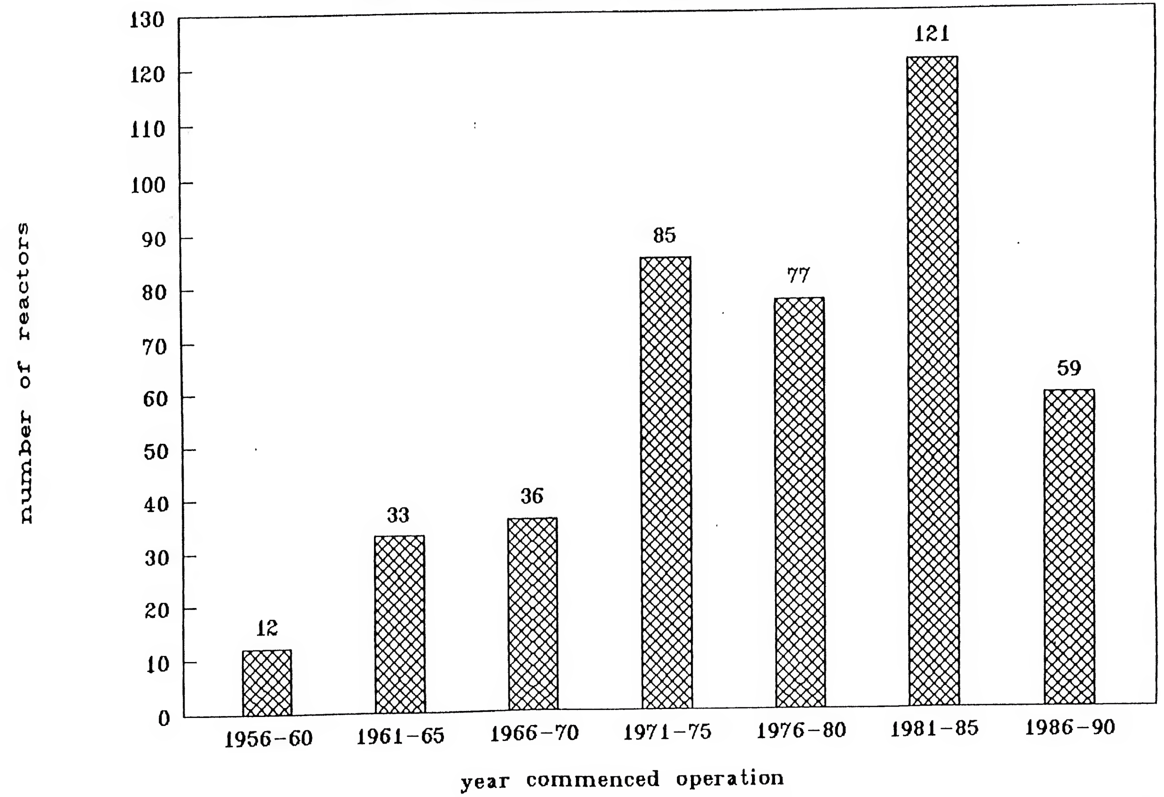
REACTOR TYPES AND NET ELECTRICAL POWER CONNECTED TO THE GRID, 31 DECEMBER 1990.

COUNTRY	PWR		BWR		Magnox		AGR		PHWR		LWGR		FBR		Other/unknown		TOTAL	
	Units	MWe	Units	MWe	Units	MWe	Units	MWe	Units	MWe	Units	MWe	Units	MWe	Units	MWe	Units	MWe
Argentina									2	935							2	935
Belgum	7	5500															7	5500
Brazil	1	626															1	626
Bulgaria	5	2585															5	2585
Canada									20	13993							20	13993
Czechoslavakia	8	3264															8	3264
Finland	2	890	2	1420													4	2310
France	52	53355			2	990							2	1433			56	55778
Germany	19	17537	7	6893													26	24430
Hungary	4	1645															4	1645
India			2	300					5	1074							7	1374
Japan	18	13071	21	17539	1	159									1	148	41	30917
Korea, Rep of	8	6591							1	629							9	7220
Mexico			1	654													1	654
Netherlands	1	452	1	56													2	508
Pakistan									1	125							1	125
South Africa	2	1842															2	1842
Spain	7	5672	2	1395													9	7067
Sweden	3	2630	9	7187													12	9817
Switzerland	3	1640	2	1312													5	2952
Taiwan	2	1780	4	3110													6	4890
UK					22	3652	14	7620					1	234			37	11506
USA	75	68604	37	32026													112	100630
USSR	24	18359									20	15754	1	560			45	34673
Yugoslavia	1	632															1	632
TOTAL	242	206675	88	71892	25	4801	14	7620	29	16756	20	15754	4	2227	1	148	423	325873

SOURCE: IAEA: NUCLEAR POWER REACTORS IN THE WORLD: APRIL 1991 EDITION

WORLD NUCLEAR REACTORS

AGE OF COMMERCIALLY OPERATING REACTORS



Reactors in the World April 1991 Edition

INTERNATIONAL SUPPLIERS OF NUCLEAR REACTORS CONNECTED TO THE NATIONAL GRID

Supplier	No of Reactors	Type of Reactor
Westinghouse	78	PWR
Framatome	55	PWR
General Electric	52	BWR
USSR (Domestic)	45	FBR, LWGR, PWR
Atomenergoexport (USSR)	18	PWR
Ontario Hydro/ Atomic Energy of Canada	18	PHWR
Kraftwerk Union	17	BWR, PWR
Combustion Engineering	15	PWR
Mitsubishi Heavy Industry Ltd	13	PWR
ASEA-ATOM	11	BWR
The Nuclear Power Co Ltd	11	AGR, MAGNOX
Toshiba Corporation	10	BWR
Babcock and Wilcox Co	8	PWR
UKAEA	8	MAGNOX
Others	64	
TOTAL	423	

Note: "Others" includes 6 nuclear reactors in Taiwan for which data are not available.

Source: IAEA: Nuclear Power Reactors in the World: April 1990.

ANNEX B

FAST REACTOR WORK OUTSIDE THE UK

FRANCE

1 France has 2 fast reactors - Phenix, which is a prototype of a different design from the PFR at Dounreay, and Superphenix (1200 MW) located at Creys Malville, near Lyon, which is run by an international consortium called NERSA (Centrale Nucleaire Europeenne a Neutrons Rapides SA) which is 51% owned by EdF, 33% by the Italian utility ENEL and 16% by the largely German-owned SBK (Schnellbruter Kernkraftwerkgesellschaft). (Belgian and Dutch utilities each have a 14.75% share in SBK; there is also a 1.65% share, formerly held by the CEGB and now held by Nuclear Electric).

2. Superphenix began operation in December 1986 but was closed in March 1987 because of a sodium leak in the fuel storage vessel and was out of operation until April 1990. It was out of operation after early July, following a compressor diaphragm failure, which led to air had been drawn into the argon gas blanket. In December 1990 a heavy snowfall demolished the roof of the Superphenix turbine hall, and the reactor has yet to restart.

GERMANY

3. The German fast reactor SNR-300 (Schneller Natriumgekuhlter Reaktor) situated at Kalkar near Essen has never operated. The SPD Land Government for Nord-Rhein Westfalen refused to grant an operating licence and the German Government announced earlier this year that the reactor would close.

JAPAN

4. Japan has a small experimental fast reactor (JOYO) which does not generate electricity; and intends to complete a 280 MW MONJU prototype fast reactor in 1992. The Japanese Atomic Energy Commission's 1987 "Long Term Programme" envisages the start of construction of a demonstration fast breeder reactor (600 to 800 MW) in the latter half of the 1990s and the deployment of commercial fast reactors in the period 2020-2030 (though the utilities in Japan appear less certain about how quickly to proceed).

USSR

5. The USSR has 4 fast reactors in operation. These are:-

a. BN-600 (output 600 MW) at Beloyarsk near Sverdlovsk, operating since April 1990. Its performance has been impressive; 67% of its lifetime has been at full power;

b. BN-350 at Shevchenko on the shores of the Caspian Sea (output 150 MW), a combined power station and desalination plant;

c. 2 small test bed reactors - BR10 (15MW) and BOR60 (12 MW).

6. Construction work started on BN-800 (output 800 MW) at Beloyarsk in 1986. However plans for a 1600 MW fast reactor have been postponed.

USA

7. Plans to complete the 380 MW Clinch River fast reactor were cancelled in 1983, having been suspended by the Carter Administration in the late 1970s.

8. Fast reactor work in the USA is based on uranium/plutonium metal fuel, rather than the uranium/plutonium mixed oxide fuel, which forms the basis of the EFR programme. In 1988 USDoE placed a 3-year contract with General Electric for the development of a small fast reactor called PRISM (Power Reactor Innovative Safe Module) consisting of 155 MW reactors in groups of three. The aim is to take the concept to a point where private sector development might be possible.

ANNEX C

EUROPEAN FAST REACTOR (EFR) COLLABORATION

1. Memoranda of Understanding covering the reactor plant and fuel cycle areas and a general agreement between the Central Electricity Generating Board (CEGB) and Electricite de France (EdF) were signed in 1984. Collaboration on the design of the EFR began in March 1988 in response to a request from the European Fast Reactor Utilities Group (EFRUG) to the Design and Construction companies, now known collectively as EFR Associates (EFRA) to prepare a single European Fast Reactor design. The UK participant on EFRUG was the CEGB and is now Nuclear Electric; the UK member in EFRA is the National Nuclear Corporation (NNC Ltd). EFRUG is not an executive body but its role is to act as an enabling body, as proxy customer for the EFR, coordinating utility support for the EFR design work among the partner countries.

2. On 16 February 1989 the following 3 detailed implementing agreements were signed with the approval of the UK Government:-

a. An Agreement on the Commercial Use of Information concluded between SERENA (for France and Germany) and FASTEC (for the UK). FASTEC is owned by NNC (51%) and the AEA (49%);

b. The R & D Agreement concluded between the national fast reactor R & D organisations of the partner countries. The signatories were the AEA (UK), the Commissariat a l'Energie Atomique (CEA) and Kernforschungszentrum Karlsruhe GmbH (KfK) and Interatom GmbH; and

c. The Conceptual Design Agreement concluded between the fast reactor design companies to collaborate on the EFR design until March 1990. The signatories were NNC Ltd (UK), Novatome SA (France), Internationale Natrium-Brutreaktor-Bau GmbH (Germany), though including Belgian and Dutch interests and Ansaldo SpA (Italy).

3. The first two years of work on the Conceptual Design were completed in March 1990 and the second and more detailed phase of the design work - the Concept Validation Phase - was begun. The Concept Validation Phase Agreement has been signed and this phase of the work is expected to last until 1993.

CHAPTER 8: FUSION

8.1 This chapter considers the Department of Energy's role in promoting R & D into nuclear fusion. Controlled thermonuclear fusion offers the prospect of making available a vast new energy source for the generation of baseload electricity. Fusion powers the stars. In this process, energy is released when atoms fuse together, as distinct from the fission or splitting of heavy atoms which takes place in the nuclear power stations we know today. For man to harness the fusion process for electricity generation, the fuel used must be heated to temperatures several times hotter than the centre of the sun.

PURPOSE OF R & D

8.2 Although the principle of the basic fusion reaction is well understood, much experimental and theoretical work has still to be done to determine whether controlled fusion reactions with a net energy gain are possible and, if so, whether it is possible to construct a commercial reactor which is economic, safe, and environmentally acceptable.

8.3 The rationale of the present research effort world-wide is to establish whether or not fusion could be a technically feasible option for commercial electricity generation. Given the length of time needed to develop the technology, and establish its reliability, commercial fusion reactors are unlikely to be a practical possibility before the year 2050 at the earliest. There is no prospect of the nuclear industry taking over the lead in the development of the technology, even if its basic feasibility is shown, until well into the next century. Until then, this technology can only be developed as the direct responsibility of individual Governments or in international cooperation.

8.4 The case for investing substantial scarce resources in developing fusion as a source of power is much debated. In particular, there is considerable scope for debate about how much effort should be devoted to it, and on what timescale. There are still very substantial reserves of fossil fuel and ample stocks of uranium for the foreseeable future demands of both fossil fuelled and fission fuelled power stations. On the other hand, the raw materials required to fuel the process - deuterium and lithium - are widely and abundantly available throughout the world. Fusion may also have environmental and proliferation advantages over both thermal and fast reactors, although these remain to be demonstrated. Fusion reactors would not produce $CO2$ and disposal of wastes should be easier than for fission reactors because of the absence of long-lived heat producing high-level wastes. If fusion could be successfully developed as an economic source of power, the eventual benefits would be very great. In practice, however, because of the time needed to develop fusion, any immediate steps to reduce atmospheric pollution world-wide must rely on technologies available now or those to be available soon.

COLLABORATION

8.5 The cost, time-scale and pre-competitive nature of fusion research make it a natural subject for international collaboration. Co-operation between the Member States of the European Community commenced in the late 1950s. The European Programme was enlarged in 1973 to include the UK programme and has since been further expanded as other countries have joined the Community. Sweden and Switzerland are also involved as associate members. Since 1973, therefore, the entire UK national fusion programme has been part of this integrated Community Fusion Programme (or CFP) managed by the Commission.

8.6 The programme is executed principally by the Member States through Contracts of Association (COA) with Euratom and their direct participation in the JET (Joint European Torus) Project sited in Oxfordshire. Part of the Community's budget is returned to Member States as Euratom's contribution to the cost of work done in their laboratories as part of the COA programme. A programme of Community funded fusion research is also carried out at the EC's Joint Research Centre at Ispra in Italy.

8.7 The current annual expenditure of the whole European fusion programme is about 450 MECU (£315 million), including 110 MECU (£77 million) on JET. EC expenditure on fusion is funded out of the EC Framework Programme for Research and Development. The CFP is one of 15 specific programmes which make up the Framework Programme. The proposal for the new CFP 1990-94 envisages funding of 458 MECU (£320 million) which includes provision for work on JET and planning for a successor machine.

8.8 JET is the world's leading tokamak experiment. This form of magnetic confinement within a torus vacuum chamber was developed in the USSR in the 1950s. Encouraging results were subsequently confirmed by a number of other laboratories, including Culham, and the tokamak approach to fusion gained general scientific acceptance. Work on JET is now achieving plasma conditions close to those which would allow power yield in deuterium/tritium plasmas to equal the amount of heating being applied. Large tokamak machines are also at work in the USA and Japan. Alternative avenues of research into fusion around the world include devices such as the stellarator and the reversed field pinch.

8.9 JET's technological achievements have been widely acclaimed and have enabled the project to obtain individually parameters for plasma density, temperature, and confinement time closer to conditions required in an eventual reactor than has any other experiment. A further extension of JET for four more years from 1992 to 1996 has been proposed in the plans for a new Community Fusion Programme for 1990 to 1994. This would allow further experiments which are crucial to establishing the technical viability of fusion and would make the maximum use of the investment in the facility.

8.10 In particular the control of impurities in the plasma and their removal is still inadequate, and this contributes to the limitations of present JET performance. The new phase to 1996 would allow demonstration of effective methods of impurity control in conditions close to those needed in a successor machine. JET would also move to a deuterium-tritium based plasma in 1995 and 1996 so that the production and behaviour of alpha particles could be studied. There is a strong scientific consensus that this additional work is essential to getting full value from JET and associated experiments.

8.11 The EC Council of Ministers will shortly need to take decisions on the new CFP 1990-94, including JET extension to 1996, and, if agreed, on a new stage of the ITER (International Thermonuclear Experimental Reactor) collaboration (see 8.20).

THE UK PROGRAMME

8.12 The UK national programme of work on fusion is carried out at Culham in Oxfordshire by AEA Fusion. It is carried out under a Contract of Association (COA) with Euratom and forms part of the European Community Fusion Programme (see 8.5). In addition, the AEA is the Host Organisation for JET, the Joint European Torus, established at Culham in 1977. Currently, the cost of the national programme (after EC support) is about £20 million, which includes a UK Host Country Contribution towards JET of about £8 million. We also contribute our share of the fusion expenditure of the general budget of the European Community - about a further £27 million per annum. The bulk of UK expenditure on fusion therefore arises directly from the Community Programme financed from the EC budget.

8.13 The Programme is focussed on work which will either support the objectives of JET or contribute to the work done in the Community on a Next Step device whether in the framework of the ITER collaboration or, possibly, as a purely European venture. It contains major contributions to the understanding and control of tokamaks, based on experiments on its own tokamak device COMPASS, a range of tasks undertaken at the request of JET, and reactor and strategic studies.

8.14 This shape and focus of the national COA fusion programme reflects a review carried out by Ministers in 1988. They decided then that the UK would support a prolongation of JET to 1992 but that expenditure on the national programme should be reduced to that directly relevant to support of JET and the tokamak route to fusion. Support for other lines of fusion research would be gradually reduced. These decisions have been implemented.

WIDER INTERNATIONAL COOPERATION

8.15 During the 1980s it became clear that the road to an economic fusion reactor would likely be longer than had been previously expected and also very expensive. The Community already envisaged using successive major machines, (JET, succeeded by NET (Next European Torus) and then by a demonstration reactor DEMO) to establish the scientific and technological basis for a commercial fusion reactor. In 1987, the USA proposed that the EC, USA, USSR and Japan should collaborate, under IAEA auspices, in the conceptual design of a "Next Step" or successor generation fusion machine, ITER.

8.16 Work started on the conceptual design of ITER in 1988 and was completed last December. The design is based, like JET, on the tokamak concept of magnetic confinement of a plasma at very high temperature. The partners are now deciding whether the collaboration should proceed to an engineering design activity (EDA) phase. The Commission and some EC Member States strongly favour this approach and the Community has matched Japanese and US offers to host EDA (in the case of the Community at a site at Garching in Bavaria). Selection of the site is likely to prove the most difficult issue to be resolved before agreement can be reached on the start of the EDA phase.

8.17 The first provisional estimate is that the capital cost of constructing a machine which would realise the ITER conceptual design would be $4.9 billion (at 1989 prices), including a contingency. At least another $600 million would be needed to cover the cost of design work, the site, and supporting the necessary R & D in physics and technology.

R & D STRATEGY CONSIDERATIONS

8.18 The EC Commission in January 1990 set up an independent evaluation Board under the Chairmanship of Professor Umberto Colombo, Chairman of ENEA of Italy, to consider the options for the Community Fusion Programme, including the possibilities for proceeding to the Next Step. The Next Step involves a choice between Euratom's own programme centred on the NET machine (see 8.15) and the concept developed by the wider ITER collaboration. The Board reported in July 1990. It recommended maintaining fusion as a priority in the Community's energy research strategy. It endorsed the current general lines of the Community Fusion Programme and supported the proposal to extend the lifetime of JET. The Board recommended too that the Community's strategy should involve full commitment to the ITER concept and that Europe advance its candidacy for the site of ITER engineering design activities.

8.19 The Board also recommended that the present level of fusion expenditure in the Community of 450 MECU (£315 million) per annum should not be increased and no commitment made to the construction of a large new international fusion machine until there has been a major review of strategy in 1995, in the light of the results obtained from JET.

8.20 The immediate strategic decisions for the UK, and for other members of the EC, are on the extension of JET to 1996, on whether a new stage of the ITER collaboration should be negotiated as the framework for work on a Next Step, and on the level of financing for the Community's Fusion Programme down to 1994. Beyond that, however, it is increasingly clear that crucial decisions will be needed at the end of JET's work, and that thought needs to be given to them now.

8.21 Even assuming JET's success and an agreement on the ITER collaboration, there will be important questions about the rate at which any future work should be carried forward. One line of approach would be to press ahead as quickly as possible with a successor to JET, preferably on as international a basis as possible. This would maintain the momentum of work on fusion and facilitate the transfer of detailed operational experience from JET (and other facilities) to ITER. On the other hand, if it is accepted that there is no immediate need for fusion, a more measured approach might give time to incorporate the results of JET, including the lessons of decommissioning, into a new design and allow further studies on a range of relevant problems. It would also reduce expenditure in the near term and might lead to an improved design in due course.

8.22 It is also important to bear in mind that the ultimate value of fusion depends not only on the success of the technical inquiry but also on developments in the world energy market over a long period. A more measured approach would reduce the risk of premature commitments.

8.23 Given the costs involved and the need to mobilise the widest range of scientific and engineering support, any successor machine to JET would be developed as an international collaboration, whether purely European (NET) or in the wider framework of ITER. The European contribution would continue to be coordinated by the Commission. In such a context the role of the individual national programmes would need to be carefully considered and the Commission has already put in hand a review. Fundamental questions would need to be asked - what contribution could national laboratories make to the development of fusion, if the main line of advance is dominated by big international machines? Would their role be confined to preparatory or confirmatory experiments, or would they be involved in using small experiments to investigate and confirm innovative lines of research? Should a national programme expect to play a significant part both in the development of the physics experiment and in work on engineering and materials? Do national laboratories have a role in ensuring a continuing supply of fusion expertise, and how large does that supply need to be? How should strategic work for the longer term, especially investigating the economic, safety, and environmental implications of fusion best be organised?

8.24 These questions would apply to the UK Programme as they apply to other national programmes. In addition there is a special element given the UK's responsibility for decommissioning JET. This work is directly relevant to many of the safety and environmental issues concerned with fusion, to whose resolution the Government attaches particular importance. These areas are therefore likely to be a major part of any future UK national programme.

8.25 The nuclear industry has expressed its view that fusion cannot be compared with the fast reactor which it views as more secure. It also considers that fusion should be clearly separated from nuclear fission research as fusion work does not support the activities of the existing civil nuclear power industry. While welcoming the Government's involvement as an indication of its interest in the very long term, the industry considers fusion should be presented as long term science-based research separate from energy R & D.

CONCLUSIONS

8.26 The Government will certainly review the UK fusion programme at the end of JET and will address these longer-term questions. In the meantime, the conclusions drawn from this Review are:-

(i) fusion is an advanced technology with a potential application in energy supply. The energy policy case for promoting R & D into fusion is to establish whether fusion can be expected to be feasible as a very long-term option for power supply. Fusion does not feature in any of the industry's future business plans. Even if results are encouraging, fusion is unlikely to be available before 2050;

(ii) it is important from the scientific point of view that JET should complete its planned programme;

(iii) the ultimate value of fusion depends not only on the success of the technical investigation but also on developments in the world energy market over a long period. A step by step approach is preferable to taking on long-term commitments;

(iv) the UK participates in an integrated European programme which brings obligations as well as benefits; and

(v) the EC continues to look for ways of increasing industrial involvement in the technology, but commercialisation lies well beyond industrial firms' planning horizons.

QUESTIONS

8.27 Comments are invited on the following questions:

(i) given the time and costs which would be needed to develop fusion as a commercial source of power, how much effort, if any, should be invested in the next ten years on establishing whether such a development is feasible?

(ii) in particular, how quickly should work proceed on a "Next Step" fusion machine? How important a factor is continuity of effort?

(iii) what contribution could national laboratories make to the Community fusion programme, including ensuring a continuing supply of expertise, if the main line of advance is likely to be dominated by big machines developed in an international context?

(iv) what priority should the United Kingdom's national fusion programme have after the ending of JET in 1996 and where should it be focussed ?

CHAPTER NINE: DECOMMISSIONING AND WASTE MANAGEMENT

9.1 This Chapter considers the extent of R & D undertaken in the UK in the field of decommissioning and waste management and the arrangements which exist for liaison between the parties commissioning that research. It examines in more detail the R & D undertaken by the AEA to support their decommissioning and waste management work, which is funded in large part by the Department of Energy.

INTRODUCTION

9.2 Government policy on management and disposal of radioactive waste in the UK in summary is that all operations leading to the generation of radioactive waste must be justified, that radiation exposure arising from radioactive wastes shall be reduced to levels which are as low as reasonably achievable, economic and social factors being taken into account, and that, on average, the dose to representative members of a critical group should not exceed 1mSv in any one year. These policy lines have been set out in various White Papers:

Cmnd 6820	Nuclear Power and the Environment	1977
Cmnd 8607	Radioactive Waste Management	1982
Cmnd 9852	Radioactive Waste	1986

9.3 Control over the disposal of radioactive waste is exercised by the Chief Inspector of HMIP (HMIPI in Scotland) and the relevant Authorising Departments under powers in the Radioactive Substances Act 1960 (as amended by the Environmental Protection Act 1990). Control over the accumulation and storage of radioactive waste on nuclear licensed sites is exercised by the Health and Safety Executive's Nuclear Installations Inspectorate, who have formal arrangements for consultation with the Authorising Departments when considering these matters.

9.4 It is the responsibility of the nuclear industry to dispose of the radioactive waste it generates. With the agreement of the Government, the nuclear industry set up Nirex in 1982 to provide a focus for research into the long-term safety of waste disposal and to provide waste disposal facilities for low and intermediate-level wastes. Nirex has continued this role since its establishment as a Company in 1985. Nirex is owned by the major UK waste producers, BNFL and Nuclear Electric 42.5% each and AEA and Scottish Nuclear 7.5% each, with the Secretary of State for Energy holding a single Special Share.

9.5 The major quantities of radioactive waste in the UK are produced by the Shareholders in Nirex and by MoD. Smaller quantities are also produced by industry, medicine and education, mainly through the use of radioactive substances.

9.6 Decommissioning operations have substantial waste management implications, since much of the material to be removed during decommissioning will be radioactive waste which will have to be disposed of. Operators have therefore to take account of the requirements of the regulatory authorities in producing their plans for decommissioning. The Government's policy is that it is for the operators to decide on the extent, timing and method of decommissioning; it is also for the operators to secure appropriate arrangements for funding decommissioning operations.

CURRENT UK RESEARCH EFFORT

9.7 Research effort in the decommissioning and radioactive waste management area may conveniently be considered in two sections: that funded by Government and that funded by the nuclear industry, ie those who create the waste and have the responsibility for dealing with it.

Nuclear Industry R & D

9.8 R & D to meet their obligations for radioactive waste is undertaken by all the major organisations in the nuclear industry. BNFL spent £17.5 m in 1990/91 on R & D into waste management and £1.8 m on R & D into decommissioning. Nuclear Electric spent £4.0 m on R & D in this area in

1990/91. MoD has a small programme linked to its own wastes and has an interest in R & D carried out by the AEA and BNFL on decommissioning plant at Sellafield for which MoD has a financial responsibility.

9.9 UK Nirex Ltd carries out R & D (£8.6 m in 1990/91) aimed at developing a disposal system for low and intermediate level wastes in the UK, including the development of waste packages and the system for the transport of packaged waste from the originator to the disposal site.

Other Government R & D

9.10 Most R & D in this area which is commissioned directly by Government Departments is commissioned by DoE. The aims of the DoE (including HMIP) R & D programme (£9.0m 1990/91) are to support HMIP's regulatory functions and DoE's wider policy responsibilities. Some changes in the direction of R & D may arise from the separation of responsibilities for commissioning research between DoE policy directorates and HMIP.

9.11 MAFF commissions research concerned with monitoring of radioactivity in the environment, and NRPB undertakes work relating to modelling of the effects of radioactivity in the environment. This relates only in an indirect way to the R & D funded by the Department of Energy.

Other

9.12 Some R & D work is undertaken independently by contractors and suppliers to the nuclear industry and by academic institutions. SERC funds some research concerned with modelling adsorption at oxide surfaces, estimated expenditure in 1990/91, £15k.

International Collaboration

9.13 The European Commission, as part of its Framework Programme, has two major relevant shared cost R & D programmes: Radioactive Waste Management with a budgeted cost over 5 years of 79.6 MECU (approximately (£56m) and decommissioning of nuclear facilities, with a value over 5 years of 31.5 MECU (about £22m).

9.14 The European Commission Joint Research Council also undertakes some generic R & D into the treatment and disposal of waste. The 1990 budget for this work was 12.8 MECU. The Commission, OECD/NEA and the IAEA are also involved in collaborative projects.

DEPARTMENT OF ENERGY FUNDED R & D

9.15 Under the arrangements agreed when the AEA was established as a Trading Fund in 1986, the Department of Energy accepted responsibility for funding decommissioning and radioactive waste management liabilities of the AEA insofar as they arose from work carried out before April 1986. The Department has also accepted responsibility for funding liabilities which have arisen since April 1986 for work carried out under Programme Letters between the Department and the AEA. The Department of Energy funds R & D undertaken by the AEA insofar as it relates to the decommissioning and radioactive waste management liabilities for which the Department has accepted financial responsibility.

9.16 The majority of AEA R & D funded by the Department of Energy is done under the Decommissioning and Radioactive Waste Management Studies (DRAWMS) Programme Letter (£6.24m 1990/91) and the Nuclear Materials Management (NMM) Programme Letter (£3.75m 1990/91). This R & D supports a major operational decommissioning and radioactive waste management programme (DRAWMOPS) with a current annual value approaching £100m. AEA also carries out, as R & D contractor, a substantial fraction (£19m) of R & D in this area commissioned by the nuclear industry and other Government Departments.

9.17 The principal areas of work under the DRAWMS Programme Letter are:

(i) production of conceptual plans for decommissioning radioactive facilities at AEA sites and identification of work needed to prepare for decommissioning;

(ii) development of techniques, methods and plant required to carry out decommissioning work safely and cost-effectively, including that required to ensure successful completion of the demonstration decommissioning of the Windscale AGR;

(iii) development of techniques, methods and plant to enable sites to handle, treat, package and dispose of radioactive waste arisings;

(iv) development of safe and cost-effective strategies for managing the variety of wastes arising on AEA sites and to develop improved strategies for tackling decommissioning tasks.

9.18 The principal areas of work under the NMM Programme Letter:-

(i) ensure that the AEA has the appropriate active handling technology and equipment needed for the safe and economic operation of its active facilities, in particular for the decommissioning of redundant facilities and the handling of wastes; and

(ii) support the development or procurement of appropriate transport packages required for the movement of radioactive materials and, in particular, wastes arising from the DRAWMOPS Programme.

Assessment of DRAWMS and NMM Requirements

9.19 By agreement with the Department of Energy, formulating, assessing and controlling the AEA's programme of research in support of the DRAWMOPS programme is largely the responsibility of the Chief Technologist (Nuclear) (CT(N)). He takes advice from a number of expert (AEA) committees dealing with relevant topics, and from the Decommissioning and Radioactive Waste Advisory Group (DROAG) which includes representatives from outside the AEA, from the Department and from the Corporate DRAWMOPS Directorate which is charged with managing the DRAWMOPS programme itself. The preferred proposals are then submitted annually to the Department of Energy in the DRAWMS and NMM Programme Letters for discussion and agreement. CT(N) may place agreed work within the AEA or with external contractors.

9.20 The main criteria which CT(N) use in assessing the merits of research proposals are:

(i) whether they are in support of the objectives of the DRAWMOPS programme;

(ii) whether they are technically feasible;

(iii) whether they will help to improve safety;

(iv) whether they will help to improve conformance with regulatory requirements; and,

(v) the cost of the proposals.

Recently the AEA has been identifying the research proposals more closely with individual DRAWMOPS projects, so that the need for the R & D work can be more easily tested, and its results monitored more effectively.

9.21 AEA report progress quarterly to the Department on the R & D and also prepare a fuller Annual Report. These reports state the major research achievements, milestones passed or problems encountered. These systems give the

Department some degree of assurance that their expenditure on R & D in support of the DRAWMOPS programme is cost effective. However this confidence depends to a significant extent on the pivotal role played by the CT(N) in judging which proposals are most likely to provide value for money in the context of the DRAWMOPS programme.

9.22 This approach raises a number of questions relating to the value for money obtained from the work, the methods by which the work was controlled and the results analysed and the coverage of the work. The Department is currently reviewing its and the AEA's procedures relating to control of the DRAWMOPS programme.

Co-ordination of R & D Effort

9.23 In the area of radioactive waste management a number of committees exist for liaison between the various organisations commissioning R & D. In addition, the Radioactive Waste Management Advisory Committee (RWMAC) regularly reviews Government and industry R & D in the waste management area and reports on the results of these reviews to the Environment Secretaries of State.

9.24 DoE has responsibility for ensuring co-ordination of R & D effort in the radwaste area. A DoE led committee published a report in 1987 entitled "Identification of Gaps in the National Research Effort related to Radioactive Waste Management". This identified very few gaps all of which have since become the subject of R & D. Some apparent duplication was identified. This work was reviewed and updated in the autumn of 1990. The 1990 review also identified relatively few gaps and noted that whilst apparently similar work may be being done by different organisations, the different objectives/circumstances involved in fact means that there is no duplication of effort in practice.

9.25 There is relatively little formal co-ordination among those carrying out R & D in the decommissioning area, because most decommissioning problems are particular to the facilities concerned. However, there is a high degree of awareness among the parties interested in decommissioning matters in the UK through informal contacts.

Coverage of R & D Programmes

9.26 The review of the Department of Energy's nuclear R & D concluded that good arrangements exist within the UK to ensure that the R & D needed to meet the identified requirements of both industry and Government is undertaken in a way which avoids unnecessary overlaps and provides the opportunity for gaps to be identified. There is no central determination of an overall R & D programme, but all the major parties are satisfied that the formal and informal contacts provide them with the information they need to draw up programmes which take full account of work being done elsewhere. The formation of International Nuclear Decommissioning between AEA and BNFL with which NE is associated has, as one of its aims, co-ordination to avoid duplication of R & D effort. There is no evidence to suggest that any of the work in current programmes is not required.

9.27 The question remains, however, whether there are R & D topics which are not presently considered by the industry or Government to be R & D requirements, but which may be of concern over longer timescales. In the context of the review of Department of Energy R & D areas which could be of importance to the future acceptability of nuclear power may be of most importance. One such area, currently a subject of international debate, concerns the possibilities of actinide separation and incineration.

9.28 The aim of actinide incineration is to physically transmute actinides and other elements which are difficult to deal with in waste management terms into nuclides which give rise to fewer waste management problems. Experience to date suggests that, in general, the elements most amenable to such treatment (eg Np and Tc) are unlikely to be a substantial problem in waste management terms. Much greater problems arise from the long-lived isotopes present in low concentration in ILW, which it is not practical to separate and concentrate for such treatment. This suggests that there would be little value in pursuing this topic further in the UK. However, there has been some re-awakening of interest in these topics within Europe (in France, the Netherlands and in the European Commission) and this may lead to further shared cost research in the Commission programmes.

Co-ordination

9.29 The review concluded that the split of responsibilities and funding of R & D amongst the various players was logically based. That which is specific to industry requirements is funded by that part of the industry concerned, and that which is specific to the needs of the regulators to understand industry proposals or to wider policy development is funded by the relevant Government Department. Because the regulators and the industry are approaching essentially the same problems from different viewpoints there are inevitably some areas where interests overlap. However, each side needs to be confident in the R & D results obtained, and a degree of overlap may, therefore, need to be accepted. Two substantial investigations by a Government/Industry Committee in the past 4 years have confirmed that in the radioactive waste management area coverage of R & D essentially meets UK requirements and with little effective overlap given the different requirements of those commissioning the research (see paragraph 9.24), though the question needs to be kept under regular review.

9.30 The review considered whether the present arrangements for co-ordination and review are sufficient to ensure that all important areas of waste management R & D are identified and investigated. Concentration of effort in recent years on R & D of more immediate interest could be leaving a gap. Very little work of a strategic, or long-term generic, nature has been undertaken in this field in the UK since the AEA and DoE began to move towards more targeted research some 4 or 5 years ago. The review concluded that a mechanism for a more specific periodic review of long-term strategic R & D requirements should be considered.

9.31 In the decommissioning area R & D is undertaken almost exclusively by the relevant parts of industry. The review concluded this was appropriate, since Government policy is that it is for industry to decide on the extent, timing and methods of decommissioning, taking account of the safety and environmental requirements of the regulatory authorities. There is nevertheless significant Government interest in decommissioning R & D where the associated work is funded by Government (DEn and MoD). MoD also funds some R & D directly in relation to its own facilities (see paragraph 9.8). In addition, there is more general interest within Government in decommissioning R & D, in the way in which its results may affect the nuclear industry's plans for decommissioning and associated waste management, where DoE has a clear policy interest.

CONCLUSIONS AND RECOMMENDATIONS

9.32 The review reached the following conclusions and recommendations:-

(i) The present split of R & D funding in the decommissioning and radioactive waste management area between industry and Government and as between Government Departments is properly based on the individual responsibilities of interested parties.

(ii) Good arrangements, through both formal and informal links, exist to ensure effective co-ordination of the R & D undertaken by all interested parties in the UK. However, this is achieved through liaison rather than active co-ordination of programme content. Better value for money might therefore be possible.

(iii) There are a considerable number of bodies with interests in the decommissioning and waste management area and in commissioning R & D to meet identified requirements. The complex relationships between these bodies are demonstrated in the functional chart at Appendix A to this chapter which was drawn up by RWMAC in 1988 (some of the names and responsibilities have since changed).

(iv) Whilst the Review considered that liaison was satisfactory, it recommended that the Department of Energy should seek views on whether better co-ordination is possible given the number of bodies involved, and on whether this might result in improved value for money either for those commissioning R & D in this area or for the UK R & D effort more generally.

(v) The R & D in the decommissioning and radioactive waste management area funded by the Department of Energy is sufficient to ensure that the DRAWMOPS work also funded by the Department can be taken forward in an effective way, and the research projects are becoming better focused on requirements identified for particular DRAWMOPS projects. Current planned levels of funding for the R & D are adequate. The mechanisms for involving the Corporate DRAWMOPS Directorate in formulating the R & D programmes also need further consideration. It is difficult to measure the cost effectiveness of the R & D in terms of its impact on the DRAWMOPS programme. The Department is currently reviewing this area.

(vi) Work currently under way on the development of waste management strategies and to identify and cost decommissioning tasks more reliably should improve the cost-effectiveness of DRAWMOPS funding. Work to develop AEA waste management and decommissioning strategies should be taken forward to provide a sounder basis for identifying future needs and funding.

(vii) Existing levels of Department of Energy funding should be maintained, subject to adequate justification being provided. They should, however, remain responsive to changing requirements, particularly as the AEA's strategic analysis and costing information improves.

(viii) Some areas of R & D of longer term importance to the future acceptability of nuclear power in the UK, mainly in the fuel cycle area may not currently be addressed by industry or Government R & D programmes. Procedures should be devised for periodic formal review of the coverage of the R & D programmes in the area of decommissioning and waste management with particular emphasis on strategic issues.

(ix) The possibilities of extending the scope of Department of Energy funded R & D into more speculative areas of forward looking research with implications in particular for the DRAWMOPS programme should be kept under review.

QUESTIONS

9.33 Comments are invited on the following questions:

(i) is there a need for better and more active co-ordination of R & D work on decommissioning and waste management in the UK, and, if so, how might this be achieved?

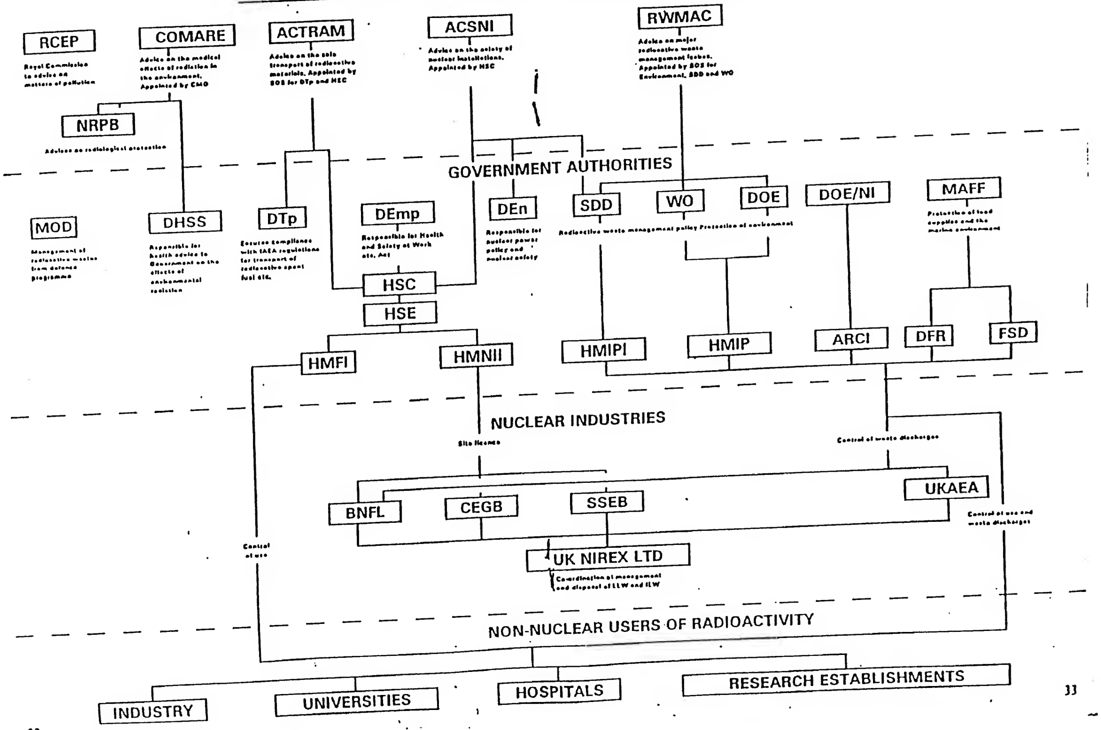
(ii) Are there R & D areas of longer-term importance to the UK, related to decommissioning and waste management, which should be considered by Government or the nuclear industry?

(iii) Should a formal review mechanism be established to consider R & D relating to strategic, long-term and generic issues, and if so, what form should it take?

(iv) Would you/your organisation be interested in contracting for any work in this area, whether of an R & D or of an operational nature?

ANNEX

RADIOACTIVE WASTE: ADVICE AND CONTROL


RCEP
Royal Commission to advise on matters of pollution
COMARE
Advice on the medical effects of radiation in the environment. Appointed by CMO
ACTRAM
Advice on the safe transport of radioactive materials. Appointed by SOS for DTp and HSC
ACSNI
Advice on the safety of nuclear installations. Appointed by HSC
RWMAC
Advice on major radioactive waste management issues. Appointed by SOS for Environment, SDD and WO
NRPB
Advises on radiological protection
GOVERNMENT AUTHORITIES
MOD
Management of radioactive wastes from defence programme
DHSS
Responsible for health advice to Government on the effects of environmental radiation
DTp
Ensures compliance with IAEA regulations for transport of radioactive spent fuel etc.
DEmp
Responsible for Health and Safety at Work etc. Act
DEn
Responsible for nuclear power policy and nuclear safety
SDD
WO
DOE
Radioactive waste management policy Protection of environment
DOE/NI
MAFF
Protection of food supplies and the marine environment
HSC
HSE
HMFI
HMNII
HMIPI
HMIP
ARCI
DFR
FSD
NUCLEAR INDUSTRIES
Site licence
Control of waste discharges
BNFL
CEGB
SSEB
UKAEA
Control of use and waste discharges
UK NIREX LTD
Co-ordination of management and disposal of LLW and ILW
Control of use
NON-NUCLEAR USERS OF RADIOACTIVITY
INDUSTRY
UNIVERSITIES
HOSPITALS
RESEARCH ESTABLISHMENTS

32

33

ANNEX

CHAPTER TEN: HOW SHOULD THE DEPARTMENT OF ENERGY COMMISSION ITS NUCLEAR R & D ?

PRESENT POSITION

10.1 At the moment, all of the Department of Energy's nuclear R & D work is carried out by the AEA - as it always has been in the past. Since the AEA was established as a Trading Fund in 1986 the work has been commissioned and monitored through a system of annual Programme Letters. Each Programme Letter describes the objectives, details of work to be done and costs in a particular technical area; milestones for monitoring progress are also presented. Total expenditure under Programme Letters in 1991/92 on nuclear R & D is estimated at £93.8 million (paragraph 3.5 provides a breakdown).

10.2 The introduction of the Programme Letter system resulted in significant improvements in the way the Department of Energy controlled its nuclear R & D programmes. At present the Department of Energy sets strategic objectives for its nuclear R & D programmes and the AEA is largely responsible for drawing up the detailed work programmes. It would be better if the customer (ie the Department of Energy) had greater involvement in detailed programme formulation, and the contractor (eg the AEA) had less. (The position on DRAWMS and NMM is somewhat different from other programmes since it is the AEA which commissions the work. See paragraph 9.19). This points to a more active role by the Department in specifying the nuclear R & D it wishes undertaken, with the contractor concentrating more on the task of managing and undertaking the work that is to be done.

10.3 To achieve these changes, the Department is becoming a better informed customer. Paragraphs 10.12 to 10.15 explain the measures introduced to achieve this end. (The Department has always been an informed customer as regards its Safeguards R & D programme arising from its executive role in this area).

THE MANAGEMENT OF NUCLEAR R & D WITHIN THE DEPARTMENT OF ENERGY

10.4 In line with the Cabinet Office's publication "R & D Assessment. A Guide for Customers and Managers of Research and Development", the Department of Energy is developing ROAME (Rationale, Objectives, Appraisal, Monitoring, Evaluation) statements for each of its nuclear R & D programmes. In general, the ROAME statement will apply at programme level, though there may be particular projects which, because of their size or particular features, might justify a ROAME statement.

10.5 Programmes and projects will not normally be approved for more than three years without at least one predetermined breakpoint at which progress will be formally assessed. Even in cases where programme objectives cannot be achieved within three years (eg fast reactor and fusion, where the development of the technology requires long-term effort) intermediate breakpoints will be established and progress reviewed at intervals of not more than three years.

USE OF CONTRACTORS OTHER THAN THE AEA

10.6 The AEA is expected to continue to be the major contractor in nuclear R & D in the UK. In some areas, such as fusion, almost all the relevant expertise in the UK resides in the AEA.

10.7 It does not, however, follow that all the Department's nuclear R & D work should be placed with the AEA. There are other commercial bodies in the UK with relevant expertise who are expected to be able to undertake some of the nuclear R & D which the Department wishes to have carried out. Universities, Polytechnics and Research Council laboratories may also want to bid to undertake nuclear R & D work in areas where they have particular expertise. The Science and Engineering Research Council (SERC) is involved in the funding of work on plasma physics in Universities.

10.8 The review concluded that the Department of Energy should exploit the possibilities of placing work with contractors other than the AEA, where this is cost-effective. (Similarly, in the case of the DRAWMS and NMM programmes, where the work is commissioned by the AEA, the AEA should consider putting work out to tender and not necessarily carry out work in-house). As the Department becomes a better informed customer, it will become better able to assess these possibilities and also able to choose between competing contractors when commissioning nuclear R & D.

10.9 The Department of Energy wishes to widen its knowledge of organisations able and willing to contract to carry out R & D within the Department's programmes. It looks to responses to this Consultation Document to assist in providing this information.

COMPETITIVE TENDERING

10.10 Where bodies other than the AEA can undertake the work, the Department of Energy will be able to choose between the bids of different contractors. The Department may identify an area in which it would wish to see work undertaken, and invite tenders against specific objectives, leaving it to contractors to propose what detailed work might be necessary to achieve the objectives. Or the Department might wish to use its Technical Unit to define a task in detail, and invite tenders against that detailed specification. Another possibility might be for the Department to select, on the basis of competitive tendering, a firm or organisation who might act as programme or project managers in a particular area of the Department's nuclear R & D work.

10.11 The introduction of competition should yield better projects, better value for money, and lower nuclear R & D costs. It should also help sharpen the financial disciplines both within the AEA and the wider nuclear industry. There is no reason why civil nuclear R & D should be treated differently from R & D into other industrial processes. In both cases, similar commercial disciplines should apply to the relationships between the customer for the R & D and the contractor.

THE DEPARTMENT AS AN INFORMED CUSTOMER

10.12 The Department of Energy already has a small number of part-time external Technical Advisers who support its nuclear R & D programmes. The Department has recently established a Technical Unit within its Atomic Energy Division. It will advise on work programmes (and timescales) required to meet the objectives of the Department's nuclear R & D programmes.

10.13 The resources of the Technical Unit will be kept under review as it gains practical experience. In cases where only the AEA is able to carry out the work the Technical Unit will advise how such work should be funded (with the intention of maximising value for money), taking into account resources required, completion dates and appropriate milestones.

PROVISION OF INDEPENDENT ADVICE ON THE DEPARTMENT'S NUCLEAR R & D PROGRAMMES

10.14 The Department of Energy already has the benefit of independent advice from its Advisory Council on Research and Development (ACORD) on its R & D programmes. At the strategic level ACORD reviews the Department's nuclear R & D programmes on an annual basis and also takes a view about the level of the Department's nuclear R & D expenditure when offering advice to the Secretary of State each year on Departmental expenditure in the context of the Public Expenditure Survey.

10.15 In addition to ACORD's advice, there may also be scope to bring additional outside expertise to bear on the Department's nuclear R & D programmes more frequently and in greater detail. The Department of Energy is therefore considering the possibility of appointing an advisory committee on its nuclear R & D programmes, comprising representatives from industry (nuclear and non-nuclear) and from other Government Departments. The role of the committee would be to review the Department of Energy's nuclear R & D programmes against the relevant ROAME statement; to advise on their success or otherwise in meeting their objectives; and to make recommendations to the Department.

CONCLUSIONS

10.16 The above analysis suggests the following conclusions:-

(i) the Department of Energy should take a more active role in specifying the nuclear R & D it wishes undertaken to meet the objectives of its nuclear R & D programmes;

(ii) the Department of Energy should seek advice on priorities and programmes from a wide variety of sources;

(iii) the Technical Unit will play a key role in this process; its resources will be kept under review;

(iv) the Department of Energy should place work under its nuclear R & D programmes with the contractor who offers the best value for money;

(v) these changes will have implications for the role of the AEA, which up to now has undertaken all the of the Department's nuclear R & D. While the AEA is expected to continue to be the major contractor in nuclear R & D in the UK for the time being, it will be competing increasingly with other contractors for the Department's work.

QUESTIONS

10.17 Comments are invited on the following questions:-

(i) Would you/your organisation be interested in providing advice to the Department of Energy on any of its nuclear R & D programmes ? and if so, in which technical areas ?

(ii) Would you/your organisation be interested in tendering for work under any of the nuclear R & D programmes of the Department of Energy ? and if so, in which technical areas ?

(iii) Paragraph 10.10 identifies two broad ways in which the Department of Energy might wish to invite tenders for its nuclear R & D programmes. It would welcome views from industry and potential contractors on the merits of either approach, or on other ways of contracting for nuclear R & D.

(iv) Would you/your organisation be interested in providing project management services to the Department of Energy in relation to its nuclear R & D work ?

CHAPTER ELEVEN: CONCLUSIONS

11.1 This Chapter sets out the review's conclusions and identifies questions on which the Department of Energy would welcome comments.

REGULATORY MATTERS

11.2 Safety

CONCLUSIONS

11.2.1 The Department should continue to fund a programme of General Nuclear Safety Research. It should look to the NII to act as its principal adviser on the content of the programme, which should include research in support of the NII's future regulatory work which could not be funded by means of levy.

11.2.2 Other Departments, notably MAFF, DoE, and the HSE's Nuclear Safety Research Management Unit, should be involved, with the NII, in drawing up the programme. The Department should have the final say about the size and content of the programme.

11.2.3 The UK/USSR collaboration funded by the programme should make a useful contribution to international efforts to support Central and Eastern European countries in bringing their nuclear safety standards up to those of EC Member States. This work is thus appropriate for Departmental funding. However, means should be established to review the effectiveness of the programme, and to co-ordinate the UK's efforts with those of other countries.

11.2.4 A start should be made immediately through the machinery proposed in 11.2.2 above on examining the balance and rationale of individual elements of the programme; the scope for collaboration with other interested Departments; the possibility of using contractors other than the AEA for parts of the programme; and whether it would be appropriate to transfer any parts of the work to the HSC's programme.

11.2.5 Work on the safety features of advanced reactor designs should be broadened to include essential projects in support of the NII's future licensing needs. A start should be made in 1992/93 and the priorities discussed as a matter of urgency between the NII, HSE and the Department. The industry should also be asked for its views. The funding implications, and the respective roles of the Department, through its GNSR programme, and of industry, through the HSE programme, need to be considered.

QUESTIONS

11.2.6 The Department would welcome comments on the following questions:-

(i) Should the Government or the nuclear industry fund R & D undertaken to support the regulatory authorities in addressing licensing issues relating to future designs of reactor, given that such designs are not currently the subject of UK licensing procedures ?

(ii) The GNSR programme is currently placed entirely with the AEA. Are there other R & D contractors with the necessary expertise to undertake work in the programme ?

(iii) Are there any significant R & D issues relating to the Department of Energy's interests as distinct from those of the industry which it would be appropriate to fund under the GNSR programme ?

11.3 Radiological Protection

CONCLUSIONS

11.3.1 There is a need for the Department of Energy to develop greater knowledge and understanding of problems facing the nuclear industry related to radiological protection. Until recently, the Department has relied on the AEA for that expertise. This is not appropriate in a customer/contractor relationship. Increased expertise in the Department of Energy is essential whatever the level of research it supports. The establishment of the Department of Energy's Technical Unit should help bring this about.

11.3.2 The Department should have the capability to decide whether there is a need for radiological protection research not currently undertaken by other bodies and, if so, how this work is best carried out.

11.3.3 The Department's RPR programme constitutes a distinct suite of research projects which contribute to the Department's overall objectives and which do not replicate work funded by other bodies.

11.3.4 The Department of Energy's programme, though small, benefits from its close association with other RPR work at the AEA. This is a factor which must be taken into account by the Department when considering using other contractors. This does not, however, preclude work being placed elsewhere; value for money and cost effectiveness are the key criteria.

11.3.5 Greater understanding of developments in RPR, their potential impact on the nuclear industry, the identification of Department of Energy needs for RPR and the consequent development of an effective programme of research can only be achieved in close liaison with other organisations. Participation in the larger AEA managed programme helps to achieve this, but closer contact is needed with other organisations undertaking research in this area, eg industry, the NII, the HMIP and the NRPB.

11.3.6 The current level of funding for the programme allows it to address a worthwhile number of specific problems not addressed by other research programmes and other bodies and gives the Department an entree to the research network which is important to the Department's overall appreciation of developments in the radiological protection area.

11.3.7 The Department should become a better informed customer of the work it funds and should develop closer relations with other bodies funding work in this area. This will enable the Department to assess more clearly what work it should be funding in RPR to meet its particular objectives, how much it should spend and whether identified research needs are better funded directly or as part of other organisations' research programmes.

11.3.8 The Department should keep its existing RPR programme under review and in particular should consider:-

(i) whether its objectives can be properly met through other research programmes given the large number of organisations involved in RPR work in the UK; and

(ii) whether it is appropriate to fund research directly or to transfer resources to more expert research-commissioning organisations, consistent with the Department's objectives being met.

QUESTIONS

11.3.9 The Department would welcome comments on the following questions:-

(i) Could the Department's radiological protection objectives be met without the need for a Department-funded research programme ?

(ii) Are the current aims of that programme appropriate ?

(iii) More generally, is the overall level of RPR funding in the UK appropriate ? Could more effective results be obtained by more closely targeted and coordinated programmes ?

11.4 Safeguards

CONCLUSIONS

11.4.1 The Safeguards R & D programme supports the UK's legal obligation to ensure that nuclear materials are used and controlled in accordance with the Euratom and the Non-Proliferation Treaties. It is right for Government to fund this programme.

11.4.2 The Safeguards R & D programme should continue to be funded and managed by the Department of Energy.

11.4.3 The Safeguards R & D programme has a clearly defined rationale, appropriate technical aims and justification, and associated prospective benefits; it is managed in accordance with accepted administrative procedures. The Department of Energy, through its Safeguards Office, is a fully informed customer of R & D commissioned in the field of safeguards.

11.4.4 The IAEA has established mechanisms to identify and set priorities for research needs on safeguards and the coordination of safeguards R & D world-wide is well-managed. Proper management and coordination of these international activities will continue to be important in the future.

QUESTIONS

11.4.5 The Department would welcome comments on the following questions:-

(i) Is the size of the programme right given the priority attached to safeguards ?

(ii) Are the objectives of the Safeguards R & D programme right ?

(ii) Can the coordination of Safeguards R & D be further improved ?

NEW TECHNOLOGIES

11.5 Reactor Technology (including the Fast Reactor)

CONCLUSIONS

11.5.1 Funding of R & D on existing thermal reactors should be for their operators - Nuclear Electric, SNL and BNFL.

11.5.2 Nuclear Electric are best placed to fund R & D to improve the competitiveness of a Sizewell-B type follow-on plant.

11.5.3 Funding of R & D on new reactor designs should principally be for the vendor, probably with some support from potential customers.

11.5.4 On the fast reactor, the review confirmed the view that the Department of Energy should not fund the operation of PFR beyond March 1994.

QUESTIONS

11.5.5 The Department would welcome comments on the following questions:-

(i) Are the conclusions in paragraph 11.5.1 to 11.5.4 appropriate ?

(ii) What is the best way to enable the UK to use fast reactors as and when they are needed ? Does continuing international collaboration make sense or would it be preferable to license the technology at the appropriate time ?

(iii) What is the appropriate level of Department of Energy spending on fast reactor technology, given that commercial deployment of a fast reactor in the UK is unlikely for 30 to 40 years at the earliest ?

(iv) Is there any scope for improvement in the work of the EFR collaboration ?

11.6 Fusion

CONCLUSIONS

11.6.1 Fusion is an advanced technology with a potential application in energy supply. The energy policy case for promoting R & D into fusion is to establish whether fusion can be expected to be feasible as a very long-term option for power supply. Fusion does not feature in any of the industry's future business plans. Even if results are encouraging, fusion is unlikely to be available before 2050.

11.6.2 It is important from the scientific point of view that JET complete its planned programme.

11.6.3 The ultimate value of fusion depends not only on the success of the technical investigation but also on developments in the world energy market over a long period. A step by step approach is preferable to taking on long-term commitments.

11.6.4 The UK participates in an integrated European Programme which brings obligations as well as benefits.

11.6.5 The EC continues to look for ways of increasing industrial involvement in the technology, but commercialisation lies well beyond industrial firms' planning horizons.

QUESTIONS

11.6.6 The Department would welcome comments on the following questions:-

(i) Given the time and costs which would be needed to develop fusion as a commercial source of power, how much effort, if any, should be invested in the next ten years on establishing whether such a development is feasible ?

(ii) in particular, how quickly should work proceed on a "Next Step" fusion machine ? How important a factor is continuity of effort ?

(iii) what contribution could national laboratories make to the Community fusion programme, including ensuring a continuing supply of expertise, if the main line of advance is likely to be dominated by big machines developed in an international context ?

(iv) what priority should the UK's national fusion programme have after the ending of JET in 1996 and where should it be focussed ?

CONCLUSIONS

11.7.1 The present split of R & D funding in the decommmissioning and radioactive waste management area between industry and Government and between Government Departments is properly based on the individual responsibilities of interested parties.

11.7.2 Good arrangements exist, through both formal and informal links, to ensure effective co-ordination of the R & D undertaken by all interested parties in the UK. However, this is achieved through liaison rather than active co-ordination of programme content. Better value for money might therefore be possible.

11.7.3 There are a considerable number of bodies with interests in the decommissioning and waste management area and in commissioning R & D to meet identified requirements. Whilst the review considered that liaison was satisfactory, it recommended that the Department of Energy should seek views on whether better coordination is possible given the number of bodies involved, and on whether this might result in improved value for money either for those commissioning R & D in this area or for the UK R & D effort more generally.

11.7.4 The R & D in the decommissioning and radioactive waste management area funded by the Department of Energy is sufficient to ensure that the DRAWMOPS work also funded by the Department can be taken forward in an effective way, and the research projects are becoming better focussed on requirements identified for particular DRAWMOPS projects. Current levels of funding for the R & D are adequate. The mechanisms for involving the Corporate DRAWMOPS Directorate in formulating the R & D programmes also need further consideration. It is difficult to measure the cost effectiveness of the R & D in terms of its impact on the

DRAWMOPS programme. The Department is currently reviewing this area.

11.7.5 Work currently under way on the development of waste management strategies and to identify and cost decommissioning tasks more reliably should improve the cost-effectiveness of DRAWMOPS funding. Work to develop AEA waste management and decommissioning strategies should be taken forward to provide a sounder basis for identifying future needs and funding. Existing levels of Department of Energy funding should be maintained, subject to adequate justification being provided. They should, however, remain responsive to changing requirements, particularly as the AEA's strategic analysis and costing information improves.

11.7.6 Some areas of R & D of longer term importance to the future acceptability of nuclear power in the UK, mainly in the fuel cycle area, may not currently be addressed by industry or Government R & D programmes. Procedures should be devised for periodic formal review of the coverage of the R & D programmes in the area of decommissioning and waste management with particular emphasis on strategic issues. The possibilities of extending the scope of Department of Energy funded R & D into more speculative areas of forward looking research with implications in particular for the DRAWMOPS programme should be kept under review.

QUESTIONS

11.7.7 The Department would welcome comments on the following questions:-

(i) is there a need for better and more active coordination of R & D work on decommissioning and waste management in the UK, and, if so, how might this be achieved ?

(ii) are there R & D areas of longer-term importance to the UK, relating to decommissioning and waste management, which should be considered by the Government or the nuclear industry ?

(iii) should a formal review mechanism be established to consider R & D related to strategic, long-term and generic issues and, if so, what form should it take ?

(iv) would you/your organisation be interested in contracting for any work in this area, whether of an R & D or of an operational nature ?

HOW THE DEPARTMENT OF ENERGY COMMISSIONS ITS NUCLEAR R & D

CONCLUSIONS

11.8.1 The Department of Energy should take a more active role in specifying the nuclear R & D it wishes undertaken to meet the objectives of its nuclear R & D programmes.

11.8.2 The Department of Energy should seek advice on priorities and programmes from a wide variety of sources.

11.8.3 The Technical Unit will play a key role in this process; its resources will be kept under review.

11.8.4 The Department of Energy should place work under its nuclear R & D programmes with the contractor who offers the best value for money.

11.8.5 These changes will have implications for the role of the AEA, which up to now has undertaken all of the Department's nuclear R & D. Whilst the AEA is expected to continue to be the major contractor in nuclear R & D in the UK for the time being, it will be competing increasingly with other contractors for the Department's work.

QUESTIONS

11.8.6 The Department would welcome comments on the following questions:-

(i) Would you/your organisation be interested in providing advice to the Department of Energy on any of its nuclear R & D programmes ? If so, in which technical areas ?

(ii) Would you/your organisation be interested in tendering for work under any of the nuclear R & D programmes of the Department of Energy ? If so, in which technical areas ?

(iii) Paragraph 10.10 of this Document identifies two broad ways in which the Department of Energy might wish to invite tenders for its nuclear R & D programmes. The Department would welcome views from industry and potential contractors on the merits of either approach, or on other ways of contracting for nuclear R & D.

(iv) Would you/your organisation be interested in providing project management services to the Department of Energy in relation to its nuclear R & D work ?

GENERAL

CONCLUSIONS

11.9.1 The review concluded that the objectives of the Department of Energy's nuclear R & D programme should be recast as:-

a. to underpin a clear regulatory framework within which current and prospective future investors in and operators of nuclear plants can work;

b. to ensure that knowledge of nuclear technologies which have potential for future energy supplies is sufficient to enable a proper assessment of them to be carried out in a timescale consistent with their likely economic deployment; and

c. to enable the AEA to discharge the decommissioning and waste management liabilities which the Department has accepted mainly as a result of past R & D programmes in a cost-effective way, consistent with acceptable levels of safety.

QUESTION

11.9.2 Are the objectives for the Department of Energy's nuclear R & D programmes, set out in paragraph 11.9.1, appropriate ?

TERMS OF REFERENCE AND MEMBERSHIP OF THE REVIEW

"For these reasons [nuclear's contribution to diversity and security of supply in curbing acid rain and combating global warming], the Government wishes to maintain the nuclear option, but only if nuclear power becomes more economic and the industry demonstrates that it can maintain high standards of safety and environmental protection." ("This Common Inheritance", 15.8)

OBJECTIVE

Against this background, to assess what nuclear R & D the Department should fund; how it can be undertaken in the most cost-effective manner; and to report to the Secretary of State accordingly.

SPECIFICALLY

1. To consider the rationale for Government support of nuclear R & D through the Department of Energy including that currently supported by the Department;

2. To review the coverage of nuclear R & D funded by the Department and make proposals for the future;

3. To consider the scope for increasing the value for money from the Department's nuclear R & D;

4. To consider the prospects for spin-off from nuclear R & D funded by the Department and the implications for funding of the programmes concerned;

5. In due course, to consider the industry's review of its nuclear R & D and its implications for the nuclear R & D funded by the Department.

In making recommendations on the above, to take account of:-

a. the Department's regulatory role in nuclear and other matters;

b. nuclear R & D funded by the nuclear industry and possible areas of overlap;

c. civil nuclear R & D funded by other Government Departments and possible areas of overlap;

d. existing Government policy, eg on the fast reactor and fusion and international commitments;

e. the requirements of the 1994 nuclear review;

f. the scope for rationalisation;

g. the prospects for increasing value for money through overseas collaboration (bilaterally, multilaterally, through the European Communities or the International Atomic Energy Authority);

h. the likely longer-term funding requirements of particular nuclear R & D programmes;

i. any proposals must be on the basis of, as a maximum, present and planned levels of Government expenditure on nuclear R & D; and

j. the primary purposes of Government R & D (as described in the Cabinet Office Annual Review).

MEMBERSHIP

Department of Energy
Treasury
Health & Safety Executive
Ministry of Defence
Department of Trade & Industry
Science & Engineering Research Council
Scottish Office
Department of the Environment
Cabinet Office

GLOSSARY OF TERMS

ABB	Asea Brown Boveri
ACORD	Advisory Council on R & D
AEA	UK Atomic Energy Authority
AGR	Advanced Gas-Cooled Reactor
ANMCO	AEA's Nuclear Materials Control Office
APWR	Advanced Pressurised Water Reactor
BNFL	British Nuclear Fuels plc
BWR	Boiling Water Reactor
CDD	Corporate DRAWMOPS Directorate (of the AEA)
CEA	Commissariat a l'Energie Atomique
CEGB	Central Electricity Generating Board
CFP	Community Fusion Programme
COA	Contract of Association
CT(N)	Chief Technologist (Nuclear), AEA
DoE	Department of the Environment
DRAWMOPS	Decommissioning and Radioactive Waste Management Operations
DRAWMS	Decommissioning and Radioactive Waste Management Studies

DROAG	Decommissioning and Radioactive Waste Advisory Group
EC	European Community
ECU	European Currency Unit
EDA	Engineering Design Activity phase
EdF	Electricite de France
EFR	European Fast Reactor
EFRA	European Fast Reactor Associates
EFRUG	European Fast Reactor Utilities Group
ENEA	Comitato Nazionale per la Ricerca e per lo Sviluppo dell' Energia Nucleare e delle Energie Alternative, Italy
ENEL	Ente Nazionale per l'Energia Elettrica, Italy
ESARDA	European Safeguards Research and Development Association
Euratom	European Atomic Energy Community
FA	Facility Attachment
GNSR	General Nuclear Safety Research programme
HMIP	Her Majesty's Inspectorate of Pollution
HSC	Health and Safety Commission
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency

ILW	Intermediate Level Waste
INFCIRC	Information Circular
ITER	International Thermonuclear Experimental Reactor
JET	Joint European Torus
JRC	Joint Research Centre
KWU	Kraftwerk Union AG
MAFF	Ministry of Agriculture, Fisheries and Food
MECU	Million European Currency Units
MITI	(Japanese) Ministry of International Trade and Industry
MoD	Ministry of Defence
MOX	Mixed oxide (fuel)
MRC	Medical Research Council
mSv	millisievert
NE	Nuclear Electric plc
NEA	Nuclear Energy Agency (of OECD)
NERSA	Centrale Nucleaire Europeene a Neutrons Rapides SA, an international consortium owned by EdF, ENEL and SBK
NET	Next European Torus
Nirex	Nuclear Industry Radioactive Waste Executive
NMM	Nuclear Materials Management programme

NNC	National Nuclear Corporation Ltd
NII	Nuclear Installations Inspectorate
NOSHEB	North of Scotland Hydro-Electricity Board
NPI	Nuclear Power International (a joint venture between KWU and Framatome SA of France)
NRPB	National Radiological Protection Board
NSRMU	Nuclear Safety Research Management Unit (of HSE)
NUCG	National Utilities' Chairmens' Group
OECD	Organisation for Economic Cooperation and Development
PFR	Prototype Fast Reactor
PIUS	Process Inherent Ultimate Safe Reactor
PRISM	Power Reactor Innovative Safe Module
PSP	Particular Safeguards Provision
PWR	Pressurised Water Reactor
ROAME	Rationale, Objectives, Appraisal, Monitoring, and Evaluation
RPR	Radiological Protection Research programme
RWMAC	Radioactive Waste Management Advisory Committee
SBK	Schnellbruter Kernkraftwerkgesellschaft (German electricity utility)
SERC	Science and Engineering Research Council

SIR	Safe Integral Reactor
SMRs	Small and Medium-Sized Reactors
SNL	Scottish Nuclear Ltd
SSEB	South of Scotland Electricity Board
THORP	Thermal Oxide Reprocessing Plant